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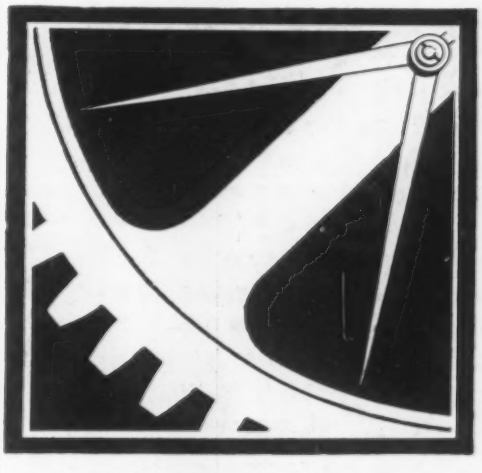
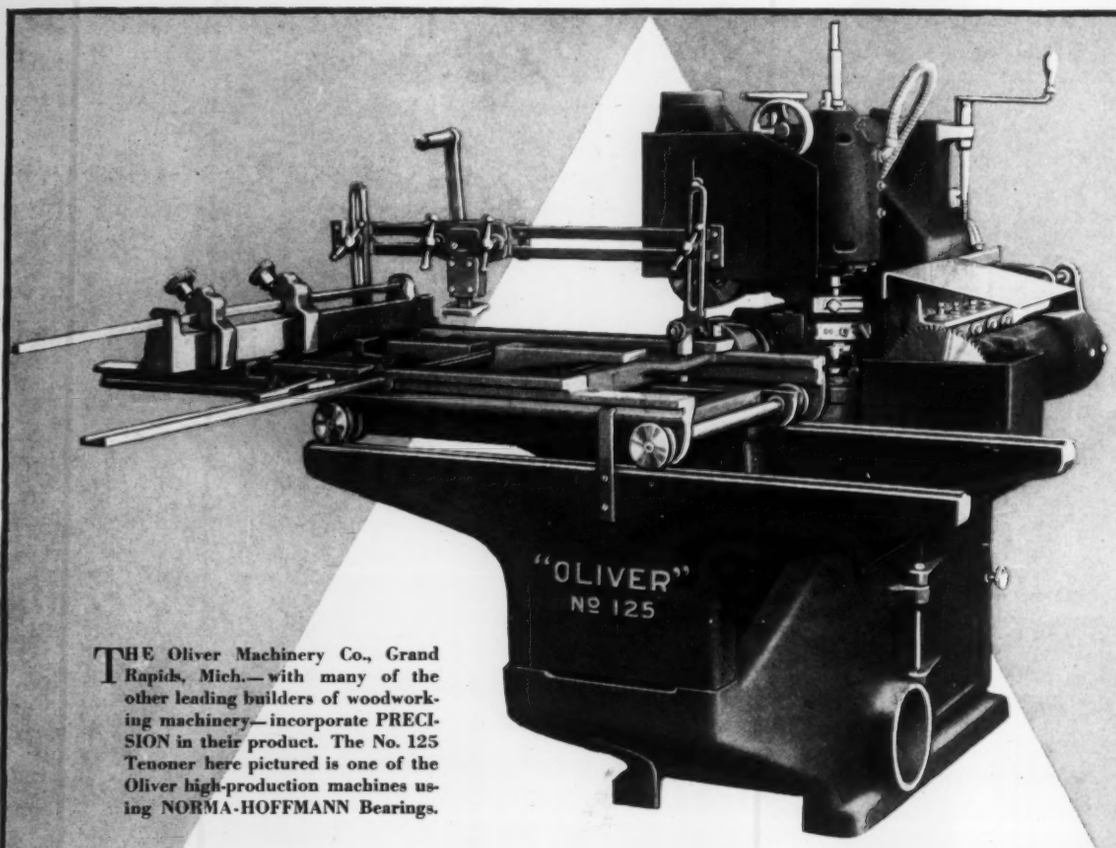
MACHINE DESIGN



AS IT AFFECTS

ENGINEERING–PRODUCTION–SALES



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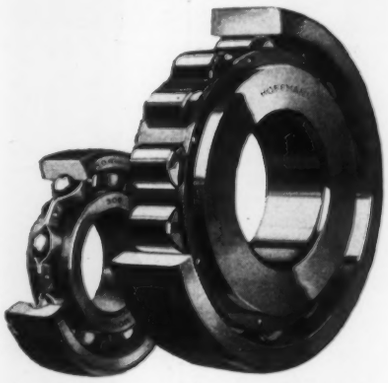

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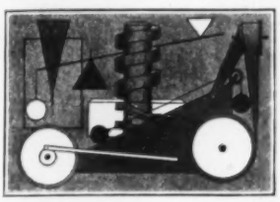
MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 2 | March, 1930 | Number 3



Forthcoming ISSUES

IN VIEW of the importance attached to employment of the hydraulic principle in present day design of machinery, MACHINE DESIGN *plans to bring to its readers the latest and most authentic information on this timely subject. Considerable space is devoted in this issue to its development, in an article by John P. Ferris, an authority on hydraulics. In a subsequent issue Mr. Ferris will write on the application of the principle in design.*

Also in forthcoming numbers will appear further timely contributions on finishing, following the article which commences on page 15, this subject being strikingly related to the sales factor in design.

L. E. Jermy
Managing Editor

CONTENTS

	Page
Overcoming Sales Resistance by Color Effects and Finishes *By William J. Miskella, M. E.*	15
Scanning the Field for Ideas	19
Reducing Machine Noises Necessary in Studying Human Factor *By L. E. Jermy*	24
Hydraulics in Design *By John P. Ferris*	27
How To Redesign a Machinery Base for Welded Construction *By E. H. Windle*	35
Geneva Wheel Is Ideal Mechanism for Indexing Movements *By George T. Chapman*	37
Trend Toward Portability Increases Use of Casters on Machines *By H. B. Veith*	39
Calculating the Moment of Inertia of Complex Sections *By John Flodin*	42
Professional Viewpoints	46
Save Men; Spend Machines (Editorial)	48
Trial Trip of Robert Fulton's "Clermont" *An Illustration by Schroeder*	49
Noteworthy Patents	50
Men of Machines	54
Leaders in Design, Engineering and Research	55
Topics of the Month	58
How Is Business?	62
New Materials and Parts	64
Assets to a Bookcase	72
Manufacturers' Publications	74
Business Changes and Sales Notes	78
Calendar of Meetings and Expositions	12

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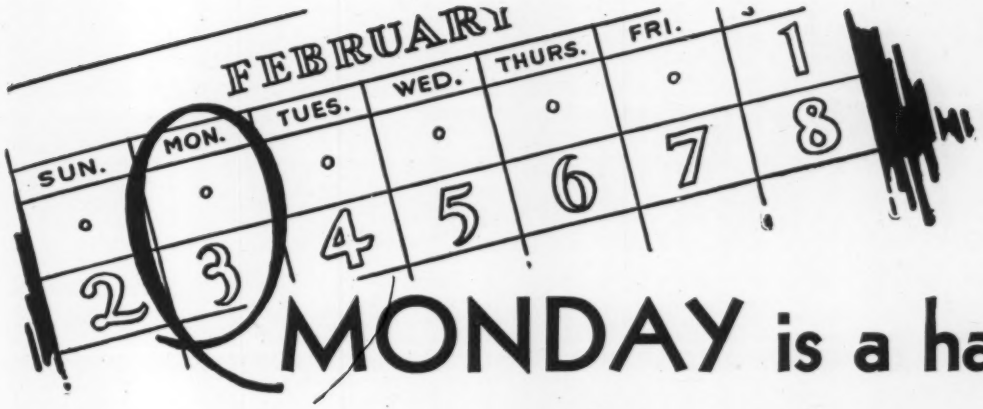

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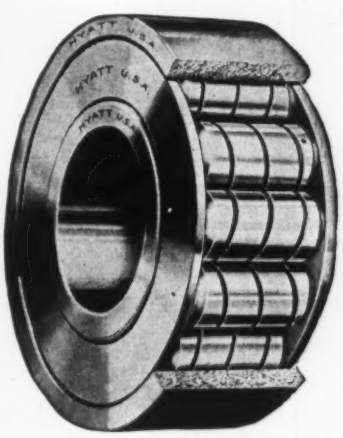

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CALENDAR OF MEETINGS AND EXPOSITIONS

Mar. 20—Electric Hoist Manufacturers association. Annual meeting at Pittsburgh. E. Donald Tolles, 165 Broadway, New York, is secretary-treasurer.

April 5-9—American Society of Mechanical Engineers. Fiftieth anniversary celebration. Opens in New York with a series of special events there and in Hoboken, where the society was founded. Sunday evening, April 6, special trains leave for Washington where headquarters will be located at Mayflower hotel, and meetings will be held in United States chamber of commerce building. The Washington program will be the main part of the celebration at which representatives of engineering societies from over the world will extend greetings. Sixteen national papers will be presented by leaders of the engineering profession from various countries. The session will be followed by conferring of honors upon a number of leading engineers. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

April 5-13—All American Aircraft Show. To be held in Detroit.

April 8-9—Society of Automotive Engineers. Technical meeting on aeronautics at Detroit. Coker F. Clarkson, 29 West Thirty-ninth street, is secretary.

April 22-25—American Welding Society. Annual meeting at society headquarters in New York. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary.

April 28-May 3—National Power Show. To be held in connection with the International Textile exposition at Mechanics building, Boston. For information write to New England Association of Commercial Engineers, 53 Devonshire street, Boston.

May 1-3—American Gear Manufacturers association. Annual meeting at Hotel Gibson, Cincinnati. T. W. Owen, 3608 Euclid avenue, Cleveland, is secretary.

May 12-16—American Foundrymen's association. Annual convention at public auditorium, Cleveland. The program provides for three round table luncheon meetings, covering malleable, steel and nonferrous foundry practice. No specially prepared papers will be presented at these informal luncheon meetings but everyone present will be given an opportunity to discuss any phase of management, metallurgical or shop practice he cares to bring up. Three shop operation courses are scheduled covering steel foundry operation, gray iron foundry operation and nonferrous foundry practice. Each course will consist of a series of three or four sessions, the leaders being assigned a definite subject for discussion. The course for nonferrous foundrymen will include crucible, open-fire and electric furnace practice. Sessions for the steel course will cover chipping, grinding, riser removal, heat treating and heat treating equipment, and core practice, while the gray iron shop operation course will comprise cupola materials, and operation, gating and risering, high test irons, alloy additions and heat treament of cast iron. C. E. Hoyt, 222 West Adams street, Chicago, is secretary.

May 19-21—American Society of Mechanical Engineers. Fifth national aeronautic meeting, Dayton, O., and Wright field. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

May 25-29—Society of Automotive Engineers. Summer meeting at French Lick Springs hotel, French Lick Springs, Ind. Coker F. Clarkson, 29 West Thirty-ninth street, New York, is secretary.

May 29-31 — American Electrochemical society. Spring meeting at Hotel Coronado, St. Louis. Colin G. Fink, Columbia university, is secretary.

June 9-12—American Society of Mechanical Engineers. Semiannual meeting to be held at the Book-Cadillac hotel, Detroit. At least 20 technical sessions besides interesting plant inspection trips and entertainment are scheduled. Jervis B. Webb, of the Detroit section, is chairman of the arrangements committee. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

June 16-20—Association of Iron and Steel Electrical Engineers. Annual meeting and iron and steel exposition at Broadway auditorium, Buffalo, N. Y. John F. Kelly, 1010 Empire building, Pittsburgh, is managing director.

June 23-27—American Institute of Electrical Engineers. Annual summer convention to be held at Toronto, Ont., Canada.

June 23-27—American Society for Testing Materials. Annual meeting to be held at Haddon Hall, Atlantic City. The program as planned will include a symposium on aircraft materials and another on rosin together with a topical discussion on some phases of testing rubber products. A number of members have offered papers for presentation.

MACHINE DESIGN
March 1930

Overcoming Sales Resistance by Color Effects and Finishes

By William J. Miskella, M. E.
Consulting Engineer, Chicago

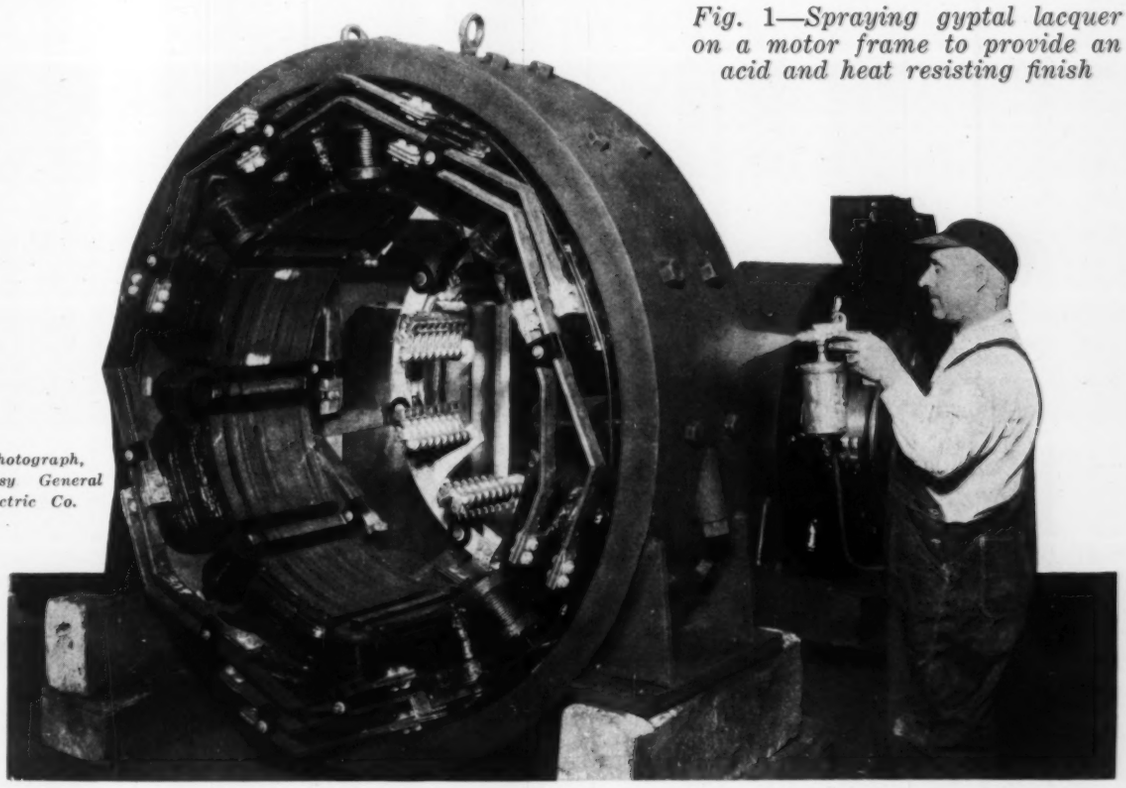
FINISH usually is one of the last things considered in designing machines. Engineers may give close attention to each machine detail from the aspects of mechanical efficiency, neatness, economy, ease of manufacture, etc. and yet neglect a factor which daily is becoming more important—appeal to the eye of the prospective purchaser.

Unfortunately the usual procedure in design is to ignore the problem of finish until everything else has been settled. Then it is too late to accord finish the attention it deserves.

A noteworthy exception to this practice recently took place in a large manufacturing plant. In this case the engineers and others responsible for design were farsighted enough to discuss the problem of finish before the design had reached the stage where it could not be changed easily.

Present at this conference were the engineer charged with the task of designing the machine,

Fig. 1—Spraying gyptal lacquer on a motor frame to provide an acid and heat resisting finish



—Photograph, courtesy General Electric Co.

the production superintendent responsible for manufacturing the various parts, the sales manager, an executive of an organization representing one of the customers of the company marketing the machine and the writer who had been called in as consulting engineer on finishes.

Engineer's Ideas Are Outlined

The engineer opened the discussion by outlining his ideas. He made a number of good suggestions, and it is certain that had it not been for this conference the design as prepared by him would have been approved without question.

However, the man who upset the plans was the executive of the company which was to buy a large percentage of the output. He declared emphatically, "This is all very fine but I must have something outstanding—something with an attractive finish. I feel the only way you can do that is to make it with an artistic appeal. It must be colorful so that it will be a sensation in its field. You men who create things seem to overlook the one big point in making a sale. It is the finish that catches the eye."

The engineer was quick to catch the spirit of the suggestion. "Oh!" he said, "I could have made up something that would fit into your idea but I was afraid it would be too extreme. Here, how would this do?"

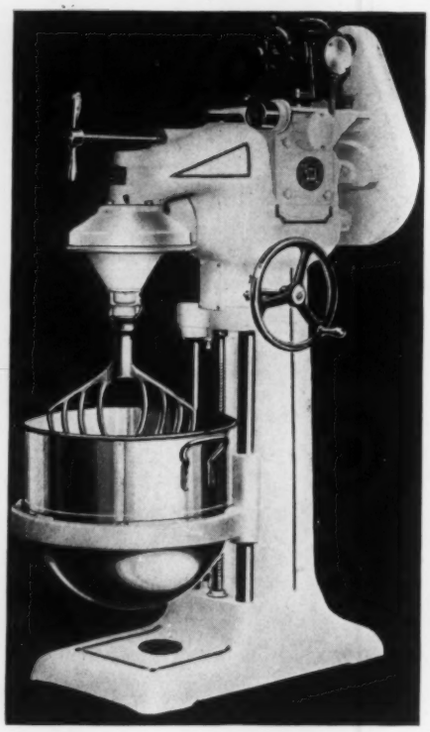


Fig. 2—Confectionery machinery requires good finish

He then proceeded to make a few rough sketches of ideas that he had cherished for a long time but which he never introduced because he had felt that the management would dismiss them as too revolutionary. The attention of the conference immediately was riveted on these apparently impromptu designs. The opinions of the finishing expert and the shop production foreman were asked. Certain important comments were made and finally the sales manager, who had said little, brought the discussion to abrupt halt.

"This," he said "is one of the most eventful mornings I have ever spent. All of you gentlemen have contributed a great deal to making it a very pleasant and instructive one. Ideas have been brought out and thoughts have been expressed which place the entire problem of merchandising upon a new plane."

Within a few minutes the details of the machine had been settled, with the unqualified approval of everyone present. The product, when introduced in a few weeks, will be entirely different from anything that has appeared on the market. Its success, which seems assured, will be due in no small measure to the decision of the management to consider all factors of design, including finish, when it is discussed in open conference.

This experience illustrates a point that will gain headway as manufacturers of machines learn to recognize the importance of finish. That point is that the design of machinery or a machine part can be laid out so as to make the finishing operation easy. It can be designed so as to make it adjustable to either a dip, brush or spray application. By coordinating the problems of finish and mechanical details, the manufacturer is able to utilize appearance of the product to the limit of its sales potentialities.

The merchandising possibilities of machine finishes are recognized more generally than ever before, yet in only a few branches of the machinery industry have consistent efforts been made to capitalize this opportunity. Designers of household mechanical equipment, automobiles and to some extent airplanes, seem to have sensed the sales value of attractive finishes. But the great majority of designers still are overlooking this opportunity.

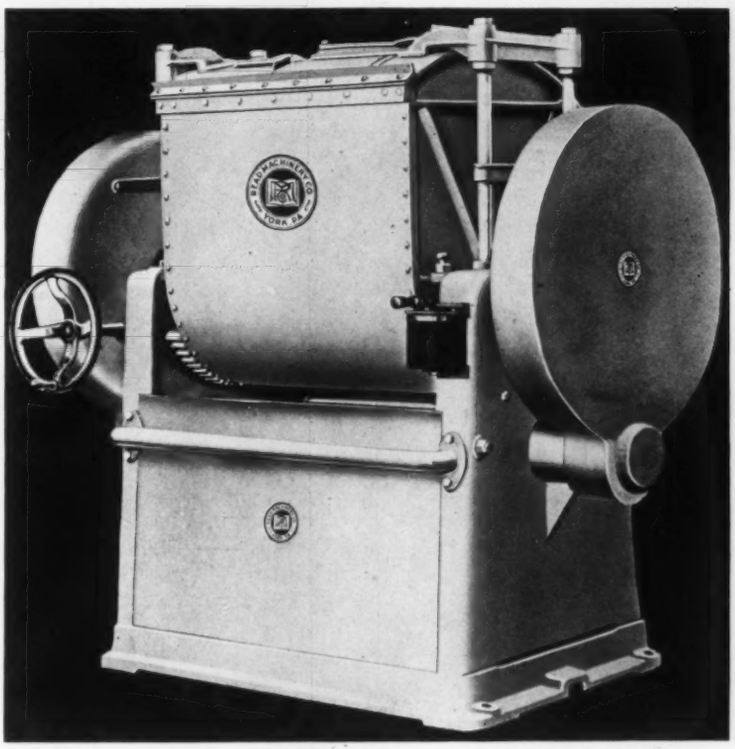
There is a logical explanation for this attitude. An inventor conceives an important idea. Usually it involves a process of performing some task better, cheaper and quicker. In due course the idea is turned over to the machine designer who makes the drawings to cover the idea. Later a model or sample may be built and tried out in service, but nothing as yet has been said about the ultimate appearance of the device.

Haste May Mean Failure in End

Everything is rushed at top speed—all due to the anxiety of the manufacturer intimately interested in seeing the machine on the market at the earliest possible moment, or possibly for this or that "season," convention, or sales conference. In this desire for speed, many important things are overlooked or at least are not given due con-

sideration, with the result that as soon as a competitor sees the new product he may immediately begin to get busy and design something similar. Who knows but that he may develop a machine which will sell in competition and which will have, above everything else, a better and more attractive appearance even though it may not have the mechanical or electrical features that are incorporated in the original model which suggested the idea. After the competitive machine is on the market the original designer may see certain attractive features which he would like to incorporate in his machine, but is prevented from doing so largely because his design is already in the production stage.

Bringing any machine product up through the various steps to the point where it is ready to have the finishing coat applied is a tremendous task when compared with the actual work and time required in the finishing and decorating operation. It is a long drawn-out period of anxiety for the engineering staff. When the end is in sight and it becomes possible to make a few deliveries, it is hard to hold back. The result is the finish is neglected and once neglected it remains so as a general rule. Therefore, would it not be far better to give a little more time and consideration to the finishing during the stages of development?



—*Photographs, courtesy Read Machinery Co.*

Fig. 3—Bread-making machines are attractively finished, not only for appearance but for sanitary considerations

The first or original designer could improve the competitive status of his machine if he would consider the finish which is to be applied, while he is planning the seemingly more important details. There would be a more secure hold on the business if this were done.

As an example of the importance of finishes, the competitive battle between Ford and General Motors is outstanding. Formerly all Ford cars were finished in black, but in the face of the severe competition it was found desirable to introduce a line of attractively finished models. Then, at the recent automobile shows Ford again attempted to be supreme in the matter of finishes. Anxious to do something outstanding to offset the public's interest in chromium plating, he dropped a bomb by announcing the standardization of unfinished rustless steel for the radiator shell, hub caps, lamp rims and other small parts.

Rustless Steel Found Preferable

With stainless or rustless steel selling at from 35 to 40 cents per pound against approximately 4 cents for ordinary steel, this was a seemingly radical departure. But the change was not introduced without careful research and tests to make sure there could be no failure.

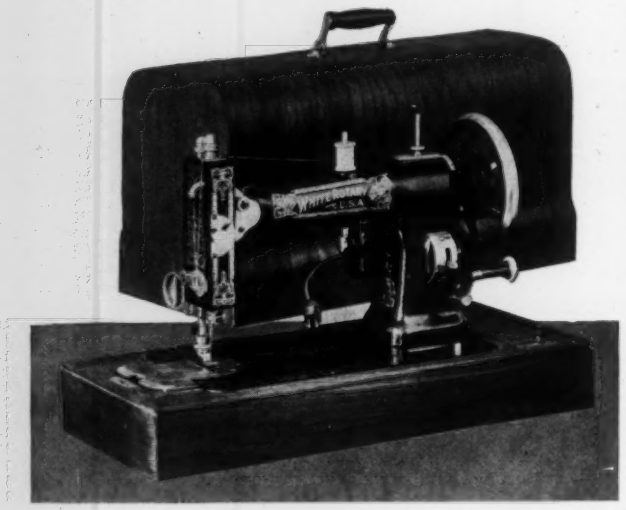
On this stainless steel there is no plated finish to peel off or crack. Once highly polished the surface seems to stay bright. But should the original brilliancy become tarnished, a little rubbing with a damp cloth will restore the polish. It is even said that the lustre quality goes clear through the metal.

Recognition of the sales appeal in attractive finishes also is apparent in other industries. At the road show, held recently in Atlantic City, the outstanding development in roadmaking machinery, as evidenced by the exhibits, was in mechanical refinements and improved finishes. Commenting on this latter feature, a writer in *Iron Trade Review* said:

"The show reflected the fact that more attention is being paid to design and appearance of this equipment than ever before. The workmanship is better. The neatness and finish of the machines has been improved. Designers have incorporated finer lines and better development of curves and angles. The recent wide-spread tendency toward the adoption of color found expression in the equipment at the show. It was noted, too, that the principal types of metal protective coatings were about equally in evidence, no one type evidently having gained the ascendancy in the field. There has been an increase,

however, in the application of aluminum paint."

In a critical survey of the Second International Aeronautical exposition, held recently in St. Louis, a writer in *Aviation* declared that "from the technical angle, there was little that was new. . . . On the other hand, the planes revealed the fact that the manufacturers are making a definite attempt to beautfy products. . . . Striking color combinations, such as orange and black, predominated in the exterior finishes."



Photograph, courtesy Apex Electrical Mfg. Co.

Fig. 4—Sales of domestic machinery are increased materially by appeal to the eye

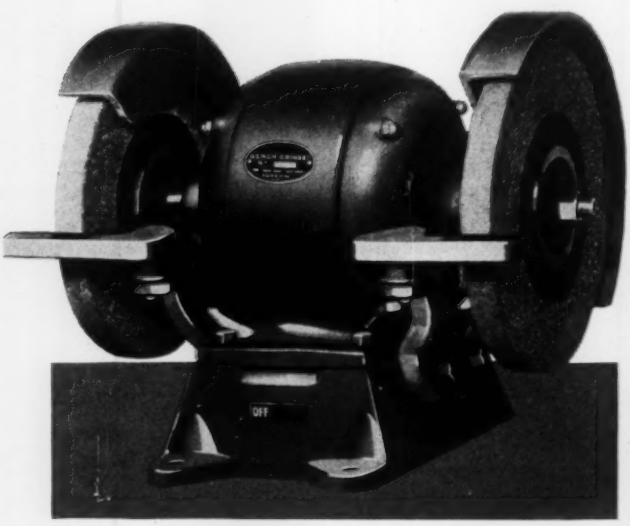
Numerous other examples might be cited to show the trend toward higher appreciation of finishes as a sales aid. The evidence is sufficiently convincing to justify every designer to investigate the possibilities in machine finishes. Unless the designer has been watching developments in this field closely, he will be amazed at the progress made in the past few years. Numerous limitations, which only a decade ago militated against the use of certain coatings on machine parts, have been removed.

Materials on which finishes are applied have been improved. The experience of office furniture and automobile body manufacturers, coupled with that of steelmakers, has resulted in the production of sheet and strip steel for deep stamping of infinitely better quality than was heretofore available for machine use. Pickling, sandblast and other cleaning operations are more effective.

Thanks to improvements in coating processes, designers now have available a greater diversity of finishes than ever before. The advent in recent years of quick drying lacquers has opened new opportunities, many of which have not thus far been sensed by manufacturers of machinery. Chromium plating has come into more general use, and while some difficulty has been experienced with it in connection with certain automobile parts, it constitutes a desirable finish when used in its proper place.

Enameling is in a period of noteworthy development. The continuous burning of enamelware was accomplished in the United States for the first time in 1929. In this process, the stock coated with vitreous enamel is conveyed through a continuous-type electric furnace at the rate of 12 feet a minute when burning a 3-coat job. The development of this and other refinements in enameling should be of interest to every engineer whose product requires this type of finish. At the present time the enameling industry is working on the problem of developing continuous automatic spraying and dipping machinery. When these efforts are crowned with success, and all enameling operations have been placed on a continuous automatic basis, the cost and quality of vitreous enameling should be very attractive to the machinery industries.

For those who want a metal that does not require a coating, there are numerous new ferrous and nonferrous alloys having the required strength, deep-drawing qualities and resistance to corrosion to suit a wide variety of purposes.



Photograph, courtesy Apex Electrical Mfg. Co.

Fig. 5—Industrial machinery should be well finished for ease of cleaning, protection, etc.

The use of these materials for certain parts of machinery used in the food industries is worth special consideration.

In view of the increased facilities for better finishes, the engineering profession has little excuse for neglecting the appearance of machines. However, in order to capitalize the opportunities of these finishes to the greatest extent, consideration of the finishing processes must take place at the time the machine is being designed, rather than left until the end and neglected.

SCANNING THE FIELD FOR IDEAS

A Monthly Review of New Machinery, Metals and Parts, with Special Attention to Significant Design Features and Trends

AT THE present rate of development, we may soon count that day lost which does not witness the introduction of a new material or a new application of an old one.

Textolite, a molded material, has many applications. Pulleys of this compound, molded to shape around Norma-Hoffmann bearings, were displayed by the General Electric Co. at the International Aeronautical exposition at St. Louis. The bearings are of the single-row, self-contained type, and the compound consists of selected sheets of linen impregnated with a phenol compound and molded under high pressure. The diameter of the pulleys is 3½ inches and the weight is 3½ ounces.

From Great Britain comes announcement of a ternary-lead alloy from which pipes and sheets can be made cheaper than those of pure lead, and with only two-thirds of its weight. The alloy was developed by the British Nonferrous Metals Research association. It consists of 98.25 per cent lead, 1.5 per cent tin and 0.25 per cent cadmium. Compared to lead its ultimate tensile strength is 84 per cent greater, its resistance to vibration is 217 per cent greater and in certain corrosive waters its resistance is superior. The commercial use of this product seems destined to develop first in pipes and sheets for plumbing, but from its properties, it also should hold interest for designers of industrial equipment.

Another new material now engaging the attention of engineers is "Thyrite" announced at the annual meeting of the American Institute of Electrical Engineers by K. B. McEachron, General Electric Co. It has the unusual property of changing its resistance to the flow of electricity as the voltage or pressure is changed. Each time the applied voltage is doubled, the resistance decreases so that the current flow is increased more than 12 times. Thyrite thus is an insulator and a conductor. It resembles black slate in color and has mechanical properties similar to those of dry-process porcelain.

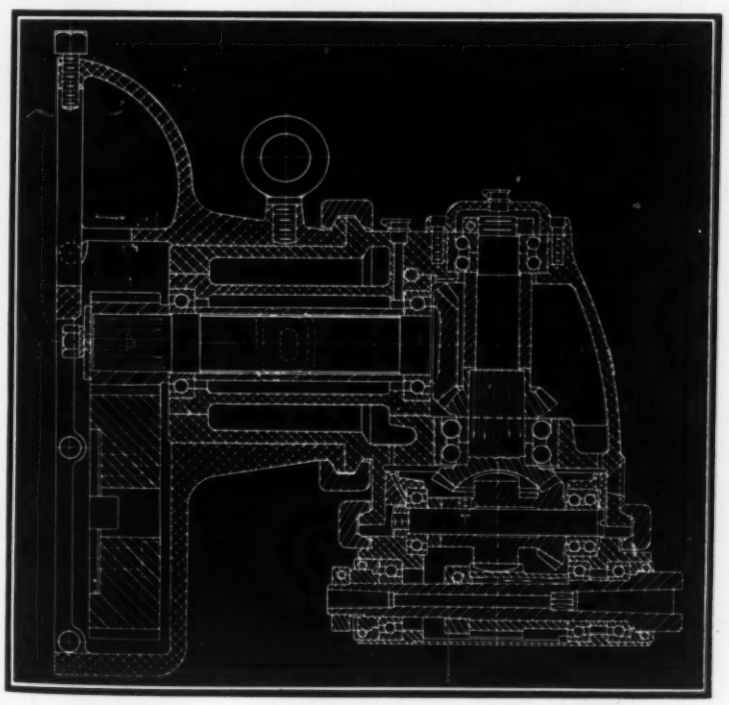


Fig. 1—Cross section of milling attachment in which aluminum alloy castings are used wherever possible

Aluminum Reduces Weight

INTERESTING applications of light metals, particularly aluminum alloys, are increasing. Uses considered impractical in the past now are a daily occurrence, with the result that portable equipment or attachments embodying the new materials can be handled with less loss of energy.

Conspicuous among machine tool attachments redesigned for the purpose of reducing weight, and which provide excellent examples of the employment of light alloys, is the universal milling attachment built by the Kempsmith Mfg. Co., Milwaukee. Internal con-

Fig. 2—Milling unit, showing ring clamps

struction of the attachment is shown in Fig. 1. Heat treated aluminum alloy castings are used for the spindle carrier, head, body, base, bearing cage and covers. The primary purpose of using the alloy was to provide a unit which could be mounted by one man without assistance, and to facilitate this further the attachment has been designed so that it may be disassembled into three sections for mounting by removing the screw in the quick acting ring clamps.

Total weight of the attachment is only 108 pounds as compared to 350 pounds weight of the attachment it superseded. Most of this saving is effected by the change in material.

It is not difficult to forsee vastly increased employment of light alloys for applications similar to the foregoing, or to visualize the beneficial effects which will occur in consequence. To picture the operator in a machine shop struggling with a heavy chuck, vise or fixture in the effort to raise it to the working position brings to mind immediately the desirability for consideration of this problem on the part of designers.

Utilizes Chain with Cutting Edges

FIG. 3 is presented to show how the familiar principle of the cutting chain has been utilized by E. Ring & Co., Berlin, Germany, in developing a machine for tree-felling and log cutting. The chain consists of hardened links with suitable teeth. An unusual feature is the arrangement by which the cutting bar can be swung through an angle of 90 degrees, to permit horizontal cutting when sawing off trees and vertical sawing when cutting the logs in the prone position. The use of chain for carrying cutting members is rather rare, which suggests the question: "Is it adapted to other applications where pulling rather than pushing action on the cutting tools is preferable?"

New Ideas Embodied in Reducers

FEW if any machine parts are receiving the attention that apparently is being devoted to gears and speed reducers. So many variations of old ideas are being incorporated in new equipment of this type that the average engineer is hard pressed to evaluate the numerous gear sets now offered for his use.

Walter Charles Pitter, London, England, is the inventor of a mechanical device called the "Revocentric" infinitely variable speed reducer. According to the Universal Gear Corp., Chicago, which now is manufacturing the product in the United States, the reducer consists of a variable throw eccentric on the input shaft, which drives five clutches through toggle joints which are mounted between two disks on the output shaft. As the eccentric moves the toggle joints, the clutches engage in the outer ring and the disk on the output shaft is moved forward by the toggle joints. The amount of forward motion of the periphery of the disk depends on the amount of throw in the eccentric. By varying the throw

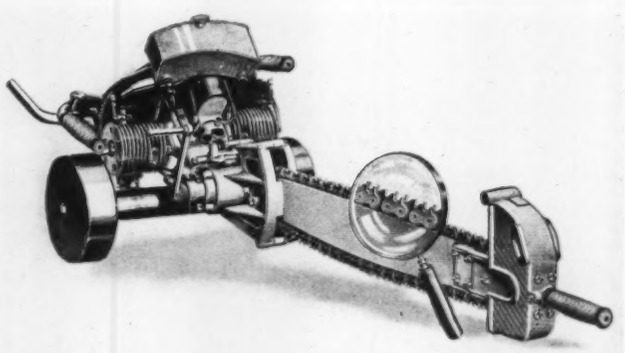


Fig. 3—Tree-felling and cutting chain saw

of the eccentric the amount of rotary motion of the output shaft is varied so that for zero throw the output shaft is stationary and for maximum throw the output shaft turns 1/13 of a revolution for each revolution of the input shaft. The reducer is not reversible. It is recommended that the input speed not exceed 1200 revolutions per minute.

Another speed reducer, introduced from England by the same company, is known as the "Heliocentric." The principle of this reducer is

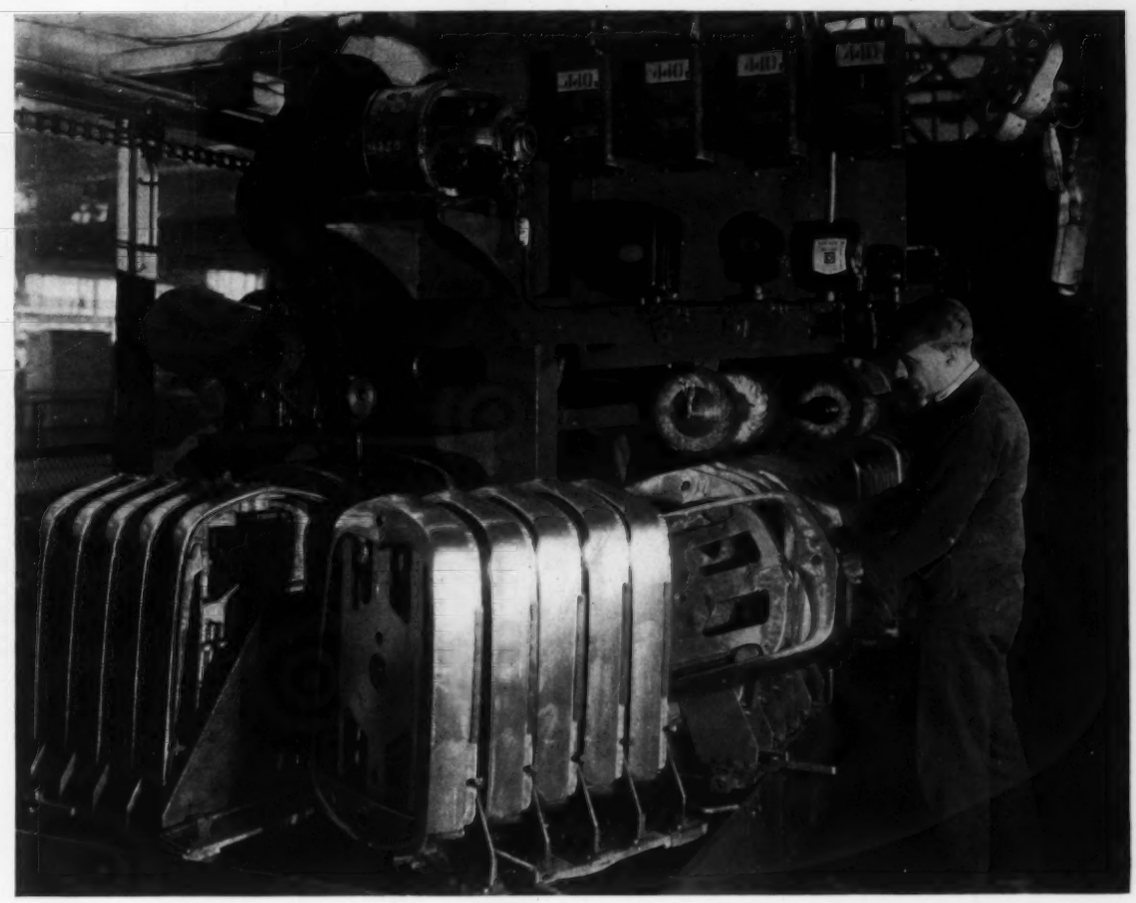


Fig. 4—Special machine used by Ford Motor Company for buffing radiator shells

A Picture Resplendent in Design Ideas

THIS illustration, taken in the plant of the Ford Motor Co. was intended to be used in connection with William J. Miskella's article on machine finishes. But when the editors began to study it, they decided it conveys so many ideas of significance to designers that its appropriate position is in "Scanning the Field for Ideas."

If you care to test our judgment, study the picture carefully. How many ideas can you find?

Here are a few. First, of course, is the use by Ford of rustless steel for radiator shells. Adoption of this special alloy for cowl strip, head lamps, hub and gas tank caps, rear lamps, radiators and radiator shells, after subjecting it to the action of 143 different acids, alkalies, salts, organic compounds, poison vapors and fluids, is a decision of significance to machine designers in whose work this type of material has possible applications.

Second is the buffing machine, which in itself embodies a number of interesting ideas. Note the endless chain of racks, each carrying jigs for five shells. The expanding clamp which grips the shell is ingenious. So also is the revolving feature of each jig which permits the operator to present each plane of the periphery to the action of the buffing wheel. Interesting no doubt, is the design by which pressure is exerted by the wheel upon the surface to be polished.

The motor drive through chain belt transmission, distribution of power to the conveyor and to the buffing wheels, electrical starting and control apparatus and other features of the machine appear clearly in the picture.

In the upper corners are link conveyors carrying shells and other parts. Seldom does a single photograph portray so much of significance to designers or reflect so realistically so many of the developments that are typical of modern American methods of manufacture.

unusual. As shown in Fig. 5, it consists of an eccentric on the high-speed shaft, driving a series of plungers assembled radially in a spool piece mounted on the low-speed shaft. These plungers engage a stationary internal gear rack and progressively move forward on the rack, carrying the low-speed shaft around with them. The number of teeth in the rack determines the speed reduction. More than a third of the total number of plungers are always working at one time, giving

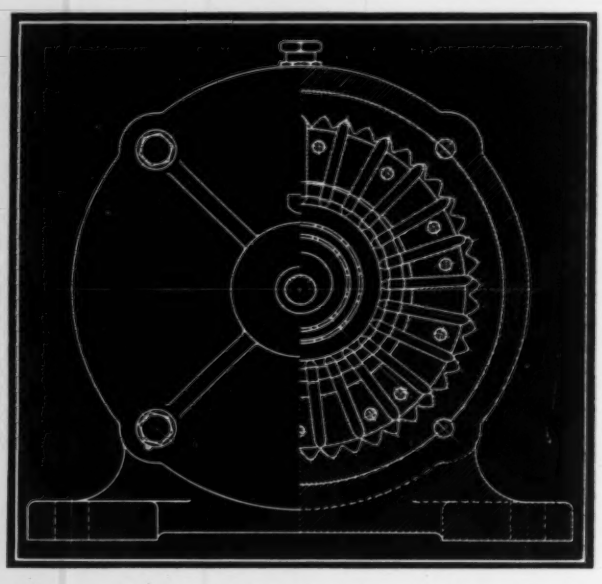


Fig. 5—Heliocentric speed reducer, showing principle of plunger engagement

a large area of contact between the plungers and the rack. The plungers have sliding friction, but the outer point of the plunger and the teeth in the rack are so designed that the plunger has a tendency to pull the oil into the point of contact between the plunger and rack. The gears are said to have an efficiency of 90 per cent at their rated load. It is apparent that this arrangement affords extremely high reductions and compactness.

The composite herringbone gears used in the transmission of Reo cars and trucks, previously mentioned in MACHINE DESIGN, continue to attract the attention of engineers. This is due not only to the novelty of employing herringbones in automobile transmission, but also to the fact that H. T. Thomas, chief engineer of the Reo Motor Car Co. and inventor of the gears, is attacking the problem of noise from an interesting angle. It will be remembered that the Reo gears differ from conventional design in that one-half of each gear has one pitch while the other half has a different pitch. It is intended that the vibrations set up by one-half of the gear be offset by the action of the other half.

This work on the part of Mr. Thomas and his staff, coupled with that of Westinghouse engineers, whose studies on the natural frequency of gears are discussed on page 25 of this issue, merits the attention of all engineers who are struggling with the problem of noise in gear trains.

Designing Planes for Safety

EFFORTS of aeronautical engineers to increase the stability of planes by augmenting the orthodox tractor propeller with one or more revolving in a horizontal plane to give lifting power may soon reach the stage where the problems will be of interest to observers in other branches of the engineering profession. Thus far Senor Juan de la Cierva, wealthy Spanish scientist, has been the outstanding pioneer in this new field. His "Autogiro," is not a helicopter. Rather it is a set of four rotating wings, each in section resembling the section of airplane wings.

E. D. Rice, Pitcairn Cierva Autogiro Co. of America, Philadelphia, describes the Autogiro in *Engineers and Engineering* as follows:

"The rotating wings revolve freely on a ball-bearing hub, mounted several feet above the fuselage, on a steel pylon structure. The wings, or vanes, are articulated by universal joints at their point of attachment, and are free to a limited degree, to flap up and down and to swing back and forth within the sweep of their circle. . . . . In flight the vanes are held out by centrifugal force alone.

"The centrifugal or tensional force tending to pull the vanes out horizontal is many times any possible lift force, which eliminates totally the need for bracing the revolving wings, in contrast with the elaborate system of bracing necessary for the fixed wing."

In striking contrast to the Autogiro is the helicopter-type plane invented by J. C. Johnson, Johnson Aeroplane Corp., Delray Beach, Fla. At the nose of the machine is the usual tractor propeller, but in addition are two horizontal propellers, one under each wing. It is understood the same source of power is employed for all three propellers, those on the wings being driven through shafting and gears. The Johnson plane is shown in Fig. 6.

Aside from the purely aeronautical problems involved, these two designs present an interesting study in the relative advantages of flexible and rigid construction for revolving blades. Out of the experience of these two pioneers may come lessons of value to designers of other types of machinery.

Rejecting and Loading Centrifugally

CENTRIFUGAL action offers many opportunities to designers. It has been embodied in the design of pumps and separators for many years. More recently it has been employed in the

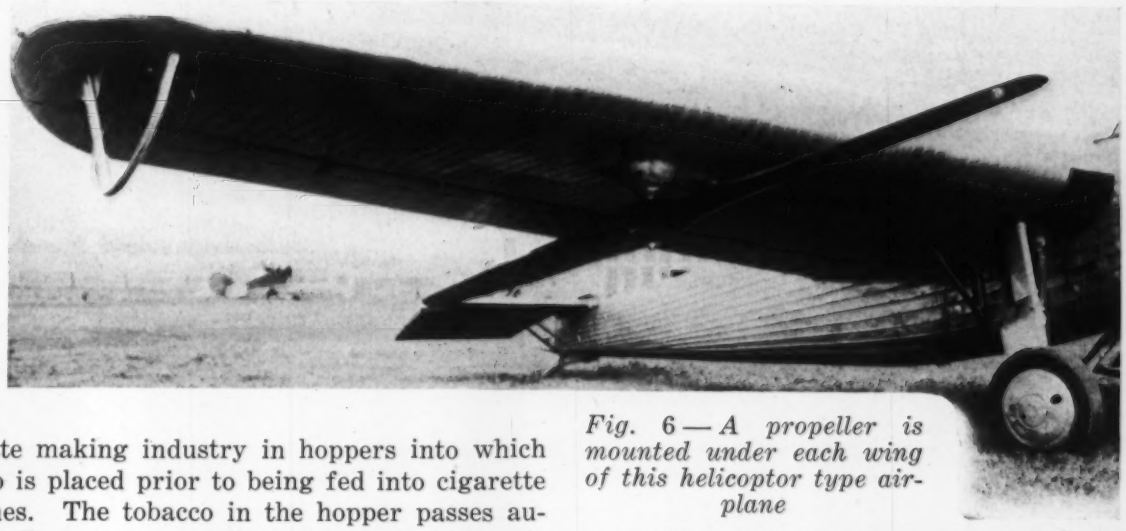


Fig. 6 — A propeller is mounted under each wing of this helicoptor type airplane

cigarette making industry in hoppers into which tobacco is placed prior to being fed into cigarette machines. The tobacco in the hopper passes automatically between cardings drums and then is engaged by a picker fan revolving at comparatively high speed. This fan is provided with fingers which reject splinters or other foreign materials by throwing them a greater distance than the tobacco, into a scrap receptacle. The latter has an adjustable wall which may be raised or lowered to suit individual requirements in regard to the degree of selectivity desired. Selected tobacco falls by gravity on a conveyor which carries it forward to the chute of the cigarette making machine. The tobacco then falls on to the cigarette paper, fed from a roll, and passes along with the paper into the folding or "rolling" mechanism which consists primarily of a folder tube through which a belt passes. The belt turns up the paper edges around the tobacco to form a cigarette rod, later cut to length.

Another recent development in the adaptation of the centrifugal principle is incorporated in the box car loader shown in the drawing in Fig. 7. The machine, built by the Stephens-Adamson Mfg. Co., Aurora, Ill., is employed for handling sand, grain, crushed stone, coal or other similar materials. In general it consists of a short endless belt driven at high speed by an electric motor. This belt is given a concave bend on the carrying surface by two disks which touch the belt only at its outer edges. Material drops between the disks and meets the belt, traveling in the same direction. As the material follows the belt around the inside of the curve centrifugal action causes it to cling to the belt with such force that it attains the speed of the belt and is thrown to the end of the car. The loader has an adjustable spur in each leg thus facilitating regulation of the trajectory.

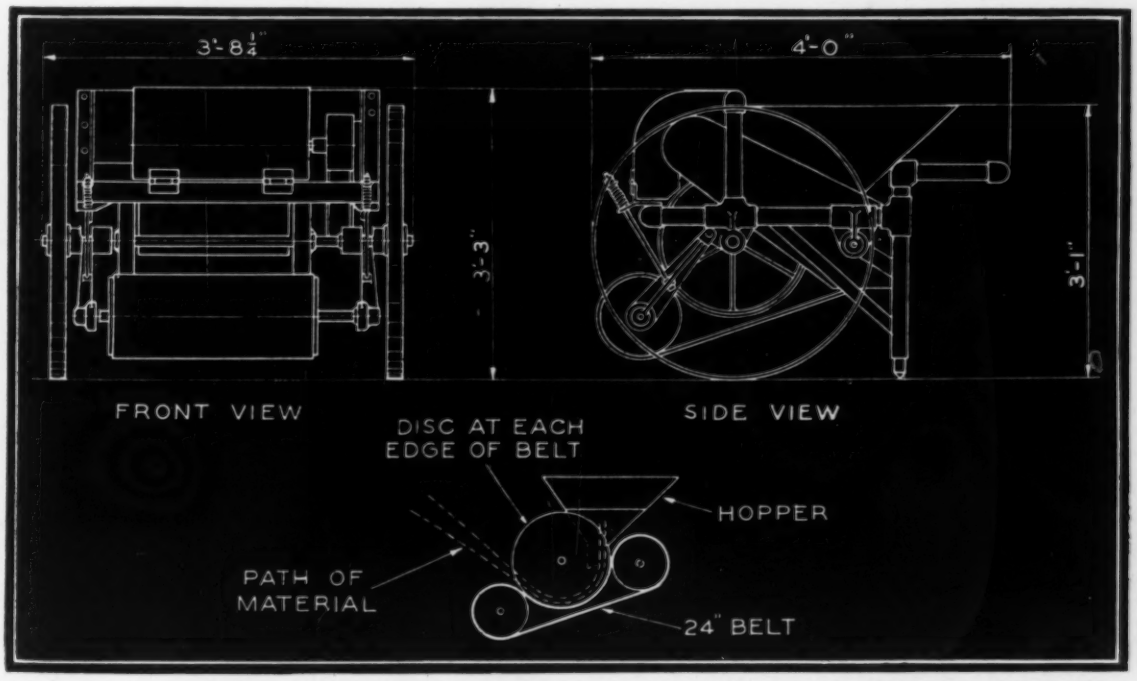


Fig. 7—Lower diagram shows how car loader hurls material from belt

Reducing Machine Noises Necessary in Studying Human Factor

By L. E. Jermy
Managing Editor, Machine Design

RECENTLY the newspapers in a large mid-western city carried an item to the effect that residents in the neighborhood of a metal stamping shop had complained to the police because the noise from machines operated at night interfered with the sleep of the complainants. The report went on to state that the police had interviewed the president of the company, who had promised to see what could be done to remedy the situation. In the meantime, it may be assumed, the irate neighbors are anxiously awaiting the result of this promise.

Engineers can readily understand the predicament of this president. One solution would be to rearrange his schedules so that work on the noisy machines can be handled in daytime. However, if this proves impossible, his next recourse would be to move the objectionable machines on to heavier and more adequately insulated foundations, to attempt to soundproof some of the surrounding walls or partitions and to determine whether or not the machines can be altered to reduce their noise. Failing in these measures, the last alternative would be to move the entire plant to a non-residence locality.

Machinery Salesman Visits Plant

At this point, let us imagine what would have happened if, after the police had left the office of this president, a salesman had entered, with a story something like this:

"Good morning, Mr. Jones. I'm sure you are going to be interested in some improvements we have made in our presses. The ones you have in the shop—you bought them from us over ten years ago—are pretty noisy. At the time we built them, nobody gave a thought to noise. It was considered a necessary evil.

"But, Mr. Jones, about a year ago our engineers began to see a new light. They came to realize that unnecessary noise is a liability. In fact, it is more than that. It affects your workmen. It's a nuisance.

"Well, our engineers began to look at design from the standpoint of noise elimination. . . . . Listen—listen Mr. Jones. Do you hear the ring, ring, ring of that idling gear out in the shop. You do? Well, our engineers found a way to cure that. We have a press now in which the gears can't ring when they're idling.

"More than that, they have gone all over the machine and have cut out all sorts of minor noises. They have studied foundations and with the help of specialists in that line have developed an arrangement that helps to keep necessary shocks and vibration within the machine itself. Our new presses do not shake the whole shop, as the old ones did.

"Mr. Jones, I wish you could see one of these new presses. I'm sure that if you could know how quiet they are in comparison to our old models, you would want to install a few to replace the oldest ones you now have.

* * *

We can imagine Mr. Jones' reply. Under the

Inestimable Value to Humanity

To the Editor:

A FEW days ago I received a copy of the February issue of MACHINE DESIGN *and have read with much interest the article "The Time Is Ripe for Engineers To Consider the Human Factor." This article is exactly in line with what we are in need of at the present time, and it seems to me that you are very likely to earn a reputation as a prophet when you take the stand that the human factor must enter into machine design in the very near future.*

This is a phase of design work which will need a lot of encouragement before it becomes reasonably developed. I feel you are entering a task that will be of inestimable value, not only to designers and engineers, but to all of humanity.

A PROFESSOR OF MACHINE DESIGN

circumstances, he would have been deeply interested, to say the least.

But while the salesman's talk happens to be pure fiction, we predict that the time is not far off when salesmen will be able to use arguments of the character cited—and use them effectively. We are confident in this prediction for the reasons set forth in the article in last month's issue, entitled "The Time Is Ripe for Engineers to Consider the Human Factor." In that discussion the thought was advanced that if engineers were to place as much emphasis on the human element in design as they now place on mechanical efficiency, the benefits to the design profession and to the machinery industries would be beyond calculation.

The present discussion is devoted to the problem of noise, because the elimination of unnecessary noise would be a boon not only to the operators of machinery but to the owners of plants in which the machines are used. Needless noise is clearly an affront to the human element in our industrial world.

Fortunately the problem is one in which every designing engineer can participate. Already research workers are attacking machine noises. The University of Michigan undertook a study of the subject several years ago. The General Electric and Westinghouse research staffs have investigated the problem. Numerous automobile engineers have delved into the causes of noise and have found remedies.

Typical of these investigations is the study of the natural frequency of gears conducted by research engineers of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. In discussing this work before the annual meeting of the American Society of Mechanical Engineers in December in New York, R. E. Peterson declared that a study of natural frequency of machine parts is important for two reasons.

Vibrates at Natural Frequency

First, if the part in question is subject to impacts it will vibrate at its natural frequency and thereby generate sound, provided the frequency is within the range of audition. Each impact will instigate a train of damped waves, while the frequency is always the same, being the natural frequency of the machine part.

In gear operation, explained Mr. Peterson, an idling condition is apt to result in pronounced

Such Reminders Are Necessary

To the Editor:

I MUST congratulate you on the article on the human factor in design and consider it is well written and the arguments well taken. It seems to me that the automobile, which you mention and, say the aeroplane are examples of complete machines where every consideration is given to the operator and to facilities for ready repair or replacement of parts. A designer of such machines must have the operator in mind all the time, otherwise the machines would not sell to the man in the street or the air. Also ease of repair, greasing, etc. must be kept to the front, consistent with cost, which cannot be unduly increased in the cheaper models. The tool kit too is kept down to a minimum.

At the other end there is the locomotive, which is absolutely necessary regardless of consideration for the operator, and therefore possibly the ease of operation is not kept so prominently before the designer.

In between are all sorts and conditions of machines, but it seems to me a designer must be strangely lacking in foresight not to give the operator every consideration, and perhaps shortcomings in this respect are due to a desire to not increase cost, which may result in unsalable machines through additional complications and devices. If improvements to the operation of the machine increase the selling price unduly the seller would have to prove corresponding output and benefit to the operator, which may not be easy when the other fellow sells at the old price.

I could imagine that a lot of designers could effect some great improvements if cost were no object.

The article you have written however, I consider to be very timely, and will no doubt help to keep your points before designers. Such reminders are necessary and always useful as everyone requires pulling up now and again to take a breather and review the situation. If you have caused some of them to ponder how they could dispose levers and handwheels to better advantage, render lubrication simple, and repair and replacement easy, together with a minimum kit of tools, and cut down noise as much as possible you will have done good service.

I'll be interested to read what some of your other correspondents have to say; men who are supervising up to date machinery. I think you will have some interesting comments.

SALES EXECUTIVE

Will Make Us More Alert

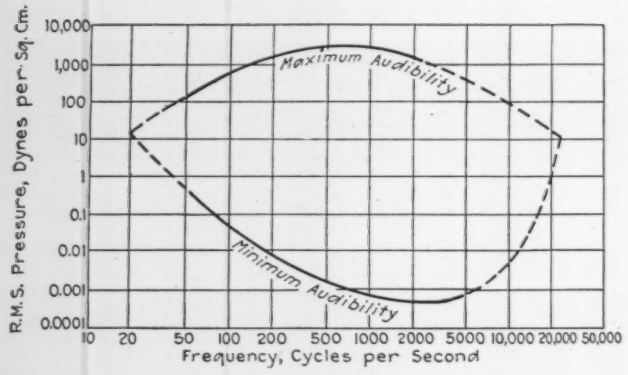
To the Editor:

I HAVE read with considerable interest the leading article in the February issue.

It is my opinion that the article is timely and pertinent and I am glad to acknowledge the contribution it has made to our own considerations of new machine designs in contemplation.

We believe we have made a more than ordinarily average advance in this particular, but frankly believe we have not been actuated by the motives so pointedly suggested in your article. These motives, we believe, will tend to make us considerably more alert to accomplish the results expressed.

TEXTILE MACHINERY MANUFACTURER



Parts will vibrate at their natural frequency if within range of audition shown

ringing. Particular examples of this occur in street cars during coasting and in punch presses when idling. This ringing sound has been shown experimentally to be of a frequency corresponding to the natural frequency of the drive gear. Light loads seem to be particularly conducive to the impact type of excitation referred to above.

Resonant Conditions May Arise

The second reason for the importance of "natural frequency" is the possibility of resonance. If the machine is operated at such a speed that a vibration occurs which is of the same frequency as the "natural frequency" of a machine part, a resonant condition occurs which may result in a tremendous increase in the amplitude of vibration. Fortunately resonance does not occur very often in gear operation in present practice. In railway gearing, for instance, the number of tooth contacts per second is of the order of 100-300, while the natural frequency of the gear is 800-1200 cycles per second. However, with increased speeds and teeth of finer pitch resonant conditions will occur more frequently than at present.

The tests discussed by Mr. Peterson were made with particular reference to railway gears of a rolled forged-steel type. He states, however, that the results if used judiciously may be applied to other types of gearing, as well as to wheels, disks, rotors, and other circular machine elements. The author presents an empirical formula for determining the natural frequency of a gear in terms of its dimensions and material. He also discusses the effect of other factors such as cutting teeth, heat treatment, etc. on the frequency. Taking all of these things into consideration it follows that after determining the frequency of a gear and referring to the chart giving the range of audition, it becomes possible for designers to avoid conditions wherein the frequency will be within the range of audition.

The Westinghouse research is to be commended because it deals with the source of noise. The more we know of the factors producing vibration and noise, the better we will be able to effect remedies. However, while progress is being made in this direction, engineers should not overlook the simpler and more direct solutions that are available. It has been known for some time that gears of certain design are much quieter than others.

Designers have made good use of this knowledge in numerous instances. The chief engineer of the Reo Motor Car Co. went a step further when in an attempt to produce a smoothly operating automobile transmission he introduced composite herringbone gears with teeth of different pitch. One-half of each gear has one pitch and the other half has another pitch. This design is based on the assumption that the vibrations set up in one-half of the gear will be nullified by those in the other half.

These and other studies on the resonance of gears and other revolving disks are of importance to every designer and the developments in this field should be watched closely.

Another illustration of what is being done to solve the noise problem is afforded by the work of General Electric engineers. At the annual convention of the American Institute of Electrical Engineers held in New York in January, L. E. Hildebrand, electrical engineer, General Electric Co., Lynn, Mass., discussed "Quiet Induction Motors." He pointed out that magnetic noise in induction motors is caused by the vibration of magnetic parts produced by the varying forces associated with the changing flux density in the adjacent air parts of the magnetic circuit.

Other Factors Cause Vibration

Torsional vibration is caused by unbalanced windings or applied voltages. Vibration of the rotor simulating a mechanically unbalanced rotor is caused by two fields differing by two poles and not of the same frequency or direction of rotation. Vibration of the stator by distortion from a circular shape results from the presence of other simple combinations of fields. Teeth tend to vibrate axially at double applied frequency.

The magnetic noise produced by a motor can be predicted from a qualitative analysis of the air-gap field supplemented by an approximate quantitative analysis and consideration of the stiffness of the parts.

With the groundwork new being laid in research laboratories, the task of noise elimination will be made easier for design engineers, and progress in solving this problem should be accelerated.

First section of a two part article dealing with a principle of increasing importance in the design of machinery

Hydraulics in Design

By John P. Ferris

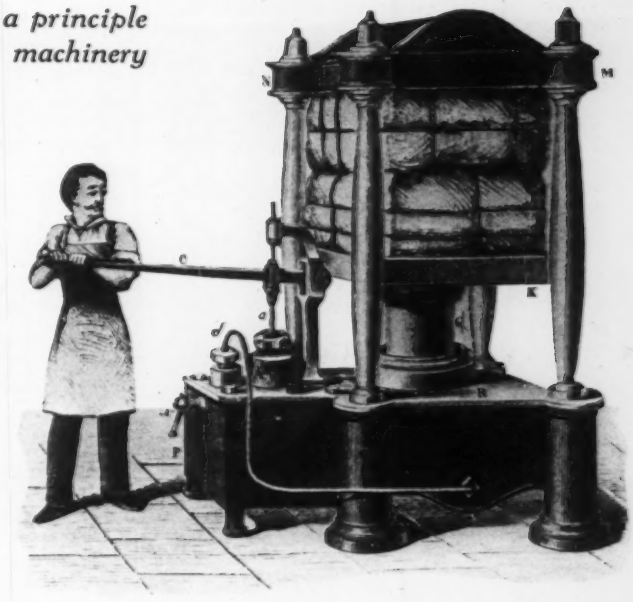


Fig. 1a—Original hydraulic press based on the discovery of Joseph Brahmah

IN RECENT YEARS a revival of interest in the possibilities of fluid under pressure for transmitting motion and power has developed. Many machines now embody hydraulic motions. Several hundred thousand motor vehicles with hydraulically operated brakes are in existence, and about eighty builders of machine tools are using hydraulic equipment. New hydraulic equipment also is used widely on machinery for metal stamping, butt-welding, assembling, driving conveyors at variable speed, furnace charging, textile machinery, handling materials, riveting, die casting, swaging, extrusion, straightening, etc.

Engineers concerned with the design of machinery now must determine to what extent their designs should be affected by the surprising renaissance in this comparatively old art. This article and the one to be printed in a forthcoming issue are intended to be of assistance in taking stock of the possibilities of hydraulics and in selecting the types of equipment best suited to the various conditions met in machine design. This first section contains a review of the types of hydraulic equipment that have been used, an idea of how they have been developed, and a picture of the characteristics of the nine general divisions into which they divide themselves. Applications to specific design problems will be treated in the next section.

Statement Recognizes Hydraulic Principle

In the middle of the sixteenth century Pascal made the following statement: "If a vessel full of water and closed on all sides has two openings, the one a hundred times as large as the other, and if each be supplied with a piston which fits it exactly, then a man pushing the small piston will exert a force which will equilibrate that of one hundred men pushing the large piston, and will overcome that of ninety-nine." It remained for an Englishman named Joseph Brahmah to discover how to make the pistons "fit the openings exactly"; he discovered the cup packing in 1785 or 1796, according to what authority you accept. This discovery resulted in the immediate use of "Brahmah's hydraulic press" for various purposes requiring large forces. Fig. 1a shows such a press, of which there are thousands in use today.

London Piped for Hydraulic Power

The invention of Brahmah took immediate hold in England due to the spectacular way in which large forces thus could be obtained. A lawyer named W. G. Armstrong, who later organized the firm which has developed into Vickers-Armstrong, Ltd., proposed the use of hydraulics for cranes in about 1845, and in 1850 he invented the accumulator to store a large amount of fluid under an artificial head. Following this invention hydraulics became exceedingly popular in England; London and other English cities were piped for hydraulic power, transmitted and sold from central pumping stations to individual shops. In 1860 Whitworth first used a large hydraulic press for forging work. The Brotherhood three-cylinder constant stroke "hydraulic engine," patented in 1873, was quite widely used for cranes, winches, etc. The dominant element in the earlier hydraulic development was the accumulator, which made it possible to overcome the slow limiting speed of the simple hydraulic power transmission system embodied in the original hydraulic

press of Fig. Ia. This press was efficient and durable, whereas the accumulator brought with it the necessity of throttling the fluid which made hydraulic installations at the height of their nineteenth century popularity inefficient and subject to excessive maintenance at the throttle valves.

About 1880, the development of hydraulics for machines apparently had reached the limit of its possibilities. Its merits adapted it for use where no other means would serve, as for example on hydraulic presses, to deliver enormous forces. Its faults generally became known about this time and there arose a disposition on the part of designers to let it alone. It simply didn't have a place on ordinary machinery.

If the accumulator had not been invented until later the need for a device which would deliver fluid smoothly, efficiently, and under control probably would have forced the development of such pumps at least 50 years ago. There is no reason why it could not have been done. We now could take Hastie's British patent of 1873 and by following it approximately build variable stroke pumps and motor units which might have prevented the hydraulic art from going into a state of doldrums from which it has emerged only during the last few years.

I wish to introduce here a term, "The New Hydraulics," which I define to include those developments of the hydraulic art which now have overcome the faults leading to its being more or less shelved about 1880. The dominant elements of the new hydraulics are variable displacement, multiple plunger pump and motor units. They will be referred to frequently here-

CHARACTERISTICS OF THE NINE BASIC SYSTEMS OF HYDRAULIC POWER TRANSMISSION

See Fig.	Systems	Typical Embodiment	Degree of Positiveness	Smoothness	Pressure in Line	Efficiency and Heating	Durability	Speed of Motor
1.	Continuous constant displacement volumetric pump and motor.	Plunger pump; 1 to 3 plungers; Hydraulic press. Reversing valve.	Positive motor speed, irrespective of load.	Pulsating motion of motor.	Proportional to load on motor.	Good efficiency at all loads. Little heating.	High durability—no "Wire drawing".	Limited by volume delivered by pump.
2.	Non-continuous constant displacement volumetric pump and motor.	Single stroke impeller pump. Single acting cyl. (no valves) hydraulic brakes.	Positive motor speed, irrespective of load.	Motor motion proportional to motion of impeller.	Proportional to load on motor.	Good efficiency at all loads. Little heating.	High durability—no "Wire drawing".	Limited by volume delivered by pump.
3.	Pump (any kind) Accumulator Throttle Constant displacement motor.	Plunger pump, 1 to 3 plungers (slow). Accumulator. Throttling valve. Hydraulic press.	Motor speed fluctuates according to load and setting of throttling valve.	Motor motion smooth if load does not fluctuate; on fluctuating load it responds to any changes in load.	Remains at maximum value ever required by work.	Low efficiency except when motor is under full load. Heating due to "Wire drawing" at throttle valve.	Subject to erosion at throttling valve seats.	Surplus of fluid stored in accumulator allows momentary motor speeds, under full load, far beyond pump capacity.
4.	Pump (any kind) Accumulator Variable displacement motor.	Plunger pump; 1 to 3 plungers (slow). Accumulator Rotary hydraulic motor, 3 pistons, Variable stroke.	Motor speed fluctuates according to load and setting of motor displacement.	Motor motions smooth if load does not fluctuate; on fluctuating load it responds to any changes in load.	Remains at maximum value ever required by work.	Good efficiency at all loads in excess of about 1/3 maximum load.	High durability—no "Wire drawing".	Adjustable motor displacement allows high speeds at lowloads. Surplus fluid in accumulator allows momentary high motor speeds under full load.
5.	Variable displacement volumetric pump and constant displacement motor.	Variable stroke, multiple plunger pump (high speed). Hydraulic press.	Positive motor speed, irrespective of load.	Smooth motion of motor, irrespective of fluctuations in load.	Proportional to load on motor.	Good efficiency at all loads. Little heating.	High durability—no "Wire drawing".	Limited by volume delivered by pump.
6.	Variable displacement volumetric pump and variable displacement volumetric motor.	Variable stroke, multiple plunger pump (high speed). Variable stroke, multiple plunger motor.	Positive motor speed, irrespective of load.	Smooth motion of motor, irrespective of fluctuations in load.	Proportional to load on motor and inversely proportional to stroke setting of motor.	Good efficiency at all loads. Little heating.	High durability—no "Wire drawing".	Adjustable motor displacement allows high motor speeds at low loads. Motor speed limited by volume delivered.
7.	Constant displacement volumetric pump. Relief valve. Throttle valve. Motor.	Gear pump. Relief valve. Throttle valve. Cylinder.	Positive only when throttle is fully open, giving full speed. At reduced speeds, motor speed fluctuates according to load and setting of throttle.	Motor motion smooth at full motor speed under all conditions. At reduced speeds, motor motion responds to any changes in load.	Proportional to load on motor only when throttle is fully open, giving full speed. At reduced speeds remains at maximum value ever required by work.	Good efficiency when throttle is fully open; at reduced speeds efficiency is low and heating occurs.	Subject to erosion at throttling valve when operating at reduced speeds.	Limited by volume delivered by pump.
8.	Turbine pump. Throttle valve. Motor.	Centrifugal pump. Throttle valve. Cylinder.	Motor speed fluctuates according to load and setting of throttle valve.	Motor motion smooth if load does not fluctuate; on fluctuating load it responds to any changes in load.	Remains approximately constant at maximum value ever required by work.	Good efficiency when throttle is fully open. At reduced speeds efficiency is low and heating occurs.	Subject to erosion at throttling valve when operating at reduced speeds.	Limited by volume delivered by pump.
9.	Alternating impulse pump and motor.	Single plunger impeller pump. Expansion chamber.	Positive within each impulse.	Oscillating motion.	Proportional to load plus forces accelerating fluid.	Should give high efficiency.	Presumably good.	Must run at same speed as pump.

after as "volumetric" pumps and motors. Such units now are available on the market over a considerable range of sizes, and are built commercially by several firms. Various combinations of these units make possible the broad use of hydraulics on machine construction. This is not to be interpreted as meaning that I believe the older hydraulic systems are obsolete, but only that the modern high efficiency, variable stroke, power units furnish the missing elements which again makes it possible for the hydraulic art to go forward. Not unnaturally, the revival of the hydraulic art which we now are witnessing carries with it a re-awakened interest in the uses to which old hydraulic developments can be put. The skeptical attitude adopted by engineers toward fluid-pressure transmission impeded its use even where the older developments were satisfactory and should have been used. The use of volumetric pump units has not superseded entirely nor should it supersede entirely the old accumulator system, or other constant pressure systems. For good reasons, volumetric hydraulics has been the agent of re-awakened interest in hydraulics in general and has received a large share of attention on this account. "Constant pressure" hydraulics also has a place in machine design, and the writer has attempted to define this place under Systems 3, 4, 7 and 8. Even the accumulator, which has been pointed out as the villain of the play, properly has a large field and this field can be greatly extended by using the accumulator in new ways in conjunction with modern variable displacement pump and motor units. An example of a fruitful alliance between the old and the new is described under System 4.

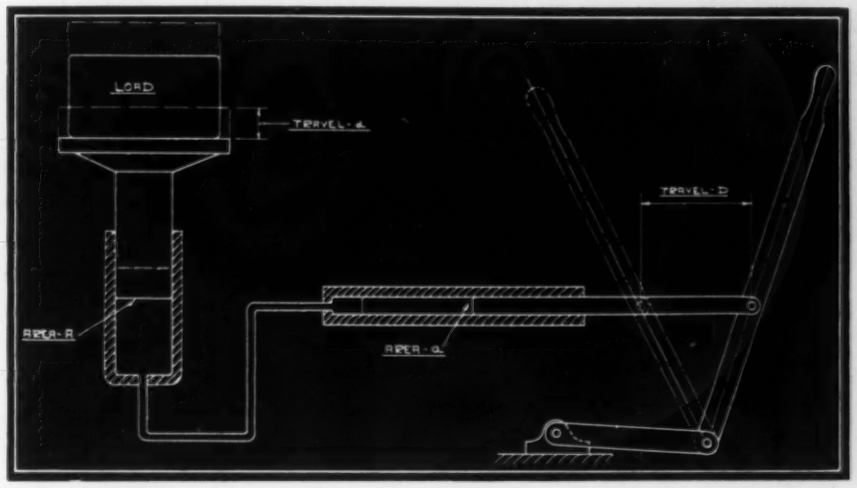


Fig. 2—Circuit diagram of non-continuous constant displacement volumetric pump with one motor

To apply hydraulics to various kinds of machinery requires that power be transmitted hydraulically under many different conditions. The methods described previously in general terms, and also many others have been devised. They may be classified in various ways, but I have chosen to divide them into nine basic systems, of which there are many variations which cannot be dealt with adequately here. The nine classes listed on the chart on page 28 will serve to bring out most of the general principles involved in this branch of the hydraulic art and will no doubt suggest to the reader other combinations that are not mentioned in the chart.

NOTE: All diagrams are simplified for the sake of clarity. In most cases some elements required for practical operation have been omitted.

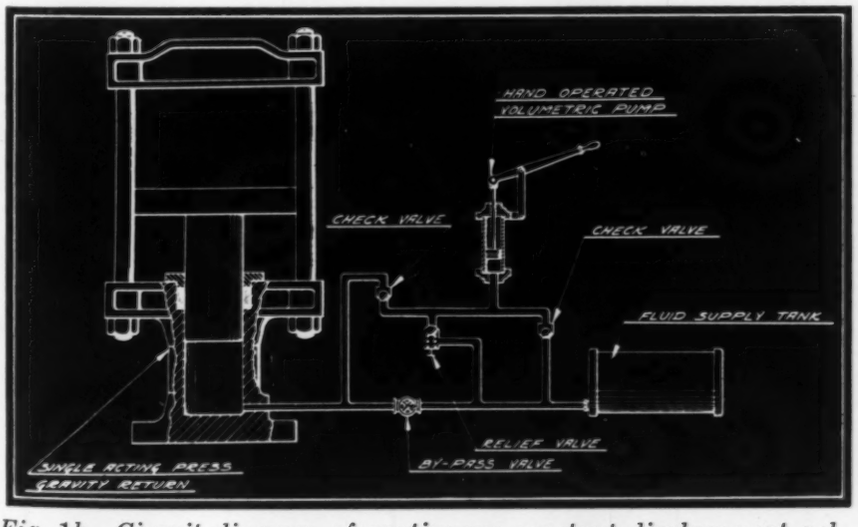


Fig. 1b—Circuit diagram of continuous constant displacement volumetric pump and constant displacement motor

The remainder of this article consists of explanatory matter concerning the nine classes on this chart. I suggest that the chart be read before the rest of the text. The diagrams used show only the fundamental principles involved; obviously no attempt has been made to indicate actual constructions or to distinguish definitely between systems which are of immediate practical interest to the designer and those which are at present of theoretical interest. It is felt that a brief survey of the entire field of hydraulics is an important preliminary to the selection of hy-

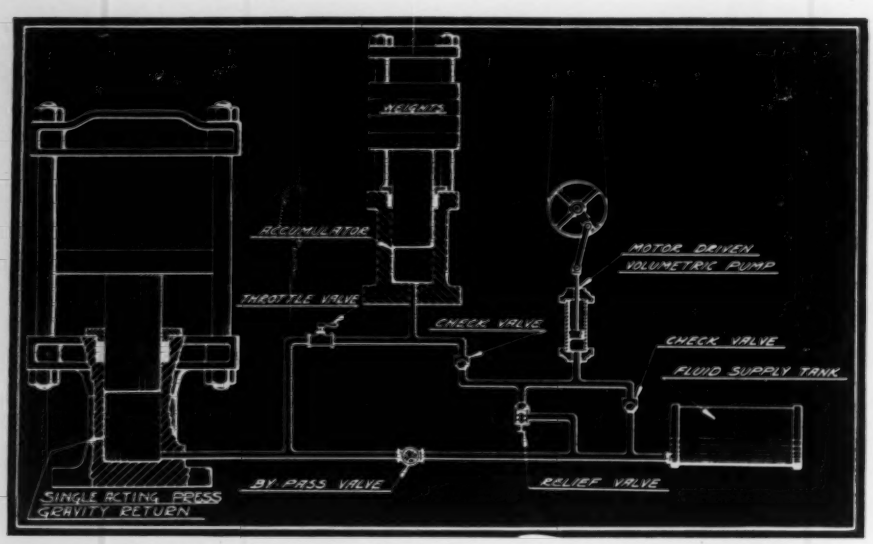


Fig. 3—Continuous constant displacement volumetric pump, accumulator throttle and constant displacement motor

draulic equipment which will produce results justifying its use.

Referring to the chart, System I is illustrated by Figs. Ia and Ib, showing a simple hydraulic press and a circuit diagram of such a press. This system is used almost exclusively on hydraulic presses, particularly where the motion of the ram need not be fast. The force exerted can be controlled by discharging the pump flow through the relief valve after the ram is stalled against the work; this relief valve can be adjustable. However, heat corresponding to the full power of the pump is liberated as long as the relief valve is open, and it generally is not feasible to hold the ram stalled against the work for any considerable time.

Basis for Automobile Brake Application

System 2 is illustrated by Fig. 2, showing a circuit diagram of a single pump and single motor cylinder; similar units have a single pump and several motor cylinders driven from the same pump. It will be observed that the system shown in Fig. 2 is similar to System I except that all valves are omitted. Ordinarily the pump does not run continuously as in System I, but makes an occasional stroke; for each stroke of the pump the motor makes one stroke, of which the length is fixed by the length of the pump stroke and the ratio of areas. In the system in which several motor cylinders are driven from the same pump nothing fixes the length of stroke of any individual motor cylinder; the various cylinders will move various distances as determined by the resistances encountered. However, the pressure in each must remain the same, with the consequence that the force exerted by each remains the same. Readers will recognize here an outline of the system used on automobile brakes. Hydraulic brakes were developed primarily because a fluid pressure power transmission system is better adapted than any other for deliverying equal forces at several different locations and in response to a single actuating motion.

System 3 is illustrated by Fig. 3, showing a simple circuit diagram. Until a few years ago this system included a large proportion of all the hydraulic installations in use. There is generally a central power plant including pump and accumulator, pipe lines leading from the power plant to the press (motor) units, and throttling valves at each press. This combination ordinarily is wasteful and a great part of the losses appear in the form of costly and troublesome destruction at the throttling valves, inherent in the system wherever rams must travel considerable distances under no load or light load. In spite of the troubles, this arrangement remained for over fifty years the best commercial solution to the problem of obtaining great forces under control for manufacturing processes. It was used for cranes, especially in Europe, but its main use is on hydraulic presses. The accumulator made practicable the transmission of large amounts of power, but at the same time it loaded the hydraulic method with such a burden of inefficiency and self-destruction that engineers learned not to use it when any other course was open.

The wastefulness of the original accumulator system of hydraulics was recognized by its early users. Most of the money spent for power went into "wire-drawing" the water at the throttle valves. Consequent erosion of the valve seats caused a large, continuous and costly leakage of water.

In the sixties and seventies of the last century, particularly in England, countless attempts were made to devise some scheme to reduce this waste and eliminate the excessive maintenance caused by it. The system shown in Fig. 4 dates back to 1872 when Rigg patented a three-cylinder "Hydraulic Engine," similar to the better known Brotherhood engine, except that the former embodied provision for varying its displacement by changing the stroke of the plungers. This engine was driven by fluid at constant pressure from an accumulator, just as was the Brotherhood engine, but it could be controlled without a

throttle valve. When maximum torque was desired, the motor was set at full displacement and the plunger forces acted on a lever arm of maximum length. If the torque obtained was greater than required to overcome the load, the operator could reduce the stroke which in turn reduced the mechanical advantage of the pistons; the torque delivered thus could be adjusted, without throttling, to any desired value within the capacity of the engine. The torque of such a motor also could be regulated automatically in response to the speed of rotation by means of a governor.

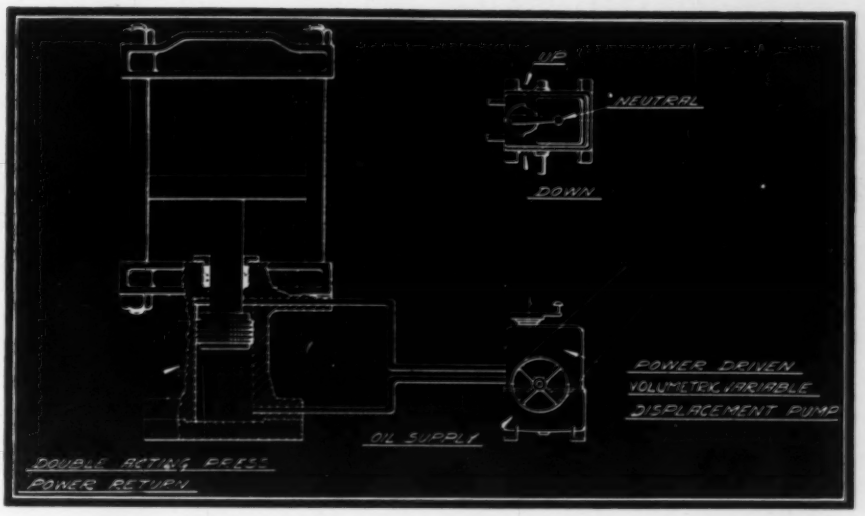


Fig. 5—Variable displacement volumetric pump and constant displacement motor

Maximum efficiency which may be expected of crank engines of this general type is about 65 per cent at full stroke and much less at low strokes. The variable displacement volumetric units today make it possible to realize the benefits of this System 4 in practice; they are mechanically reliable and operate at much higher efficiency. The two characteristics are related; high efficiency indicates low frictional losses, which in turn indicates long life.

System 5 uses the new volumetric type of pump. It is a lineal descendant of System 1, used on the original hydraulic press. The differences are that the volumetric pump used in System 5 makes possible smooth motor motion and gives control of motor speed. The first record we have of a volumetric pump with stroke control occurs in an English patent taken out also by Rigg, in 1872. It has three pistons and obviously was intended to be driven at a low rate of speed.

Although units were conceived and patented did not alter the fact that the hydraulic art became static about 1880. Beginning about 1890, a few engineers began to think of the possibility of developing multiple plunger variable stroke pumps of a type similar to those which are fully developed and widely used today. The modern volumetric pump has several plungers, is driven at high speed, and is of variable stroke. It delivers a smooth flow of fluid at high efficiency; some pumps now made have an efficiency of over 90 per cent at full load. Fig. 5 shows this system in its simplest form with a variable displacement multiple plunger pump piped directly to a hydraulic press. In these units the displacement may be changed by changing the stroke, and the direction of flow may be reversed without change in direction of rotation.

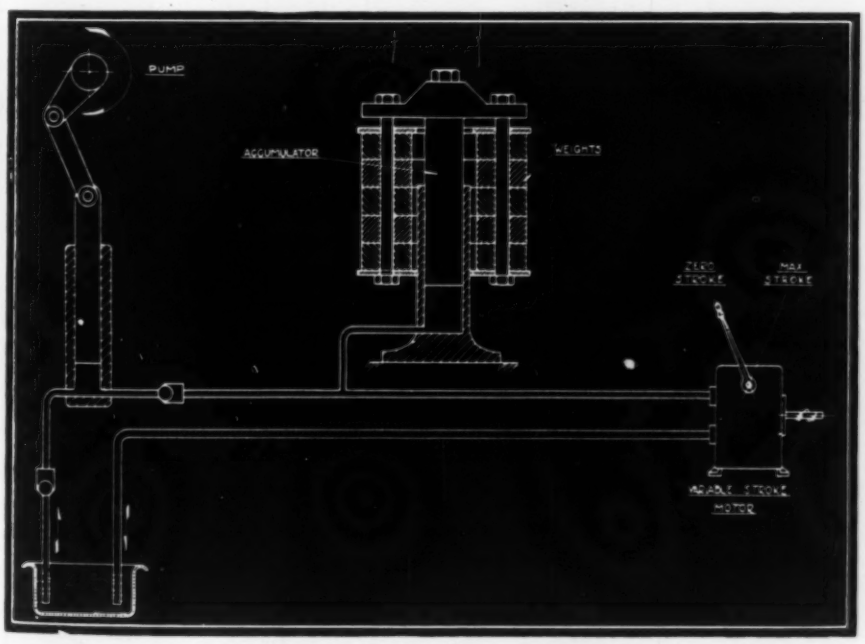


Fig. 4—Constant displacement pump, accumulator and variable stroke motor

Many engineers have put their efforts into the development of the modern volumetric pump and motor units. A complete list of inventors in this field would include at least three hundred names. One company has built pump and motor units of this type since about 1906; until recently most of them were used for military

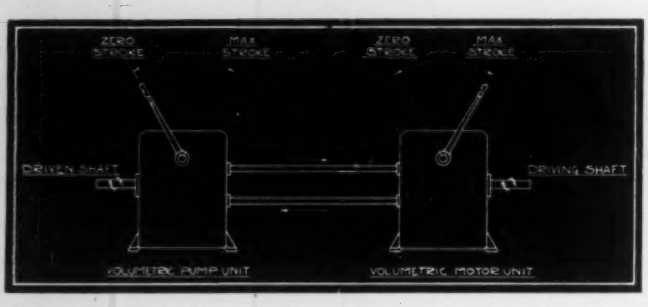


Fig. 6—Variable displacement volumetric pump and variable displacement volumetric motor

and naval purposes. The general use of volumetric hydraulics on industrial machinery began, I believe, with the introduction of the hydraulic broaching machine in 1922.

In the constant pressure method described previously under System 3, a source of liquid (generally water) under constant high pressure is provided, of volume sufficient to give the required displacement, and a throttling valve is located between this source of liquid under pressure and the motors which do the work. The fluid source may be a mill dam or an accumulator. The resistance of the work raises as much pressure in the motor as is required to overcome the resistance, which pressure is transmitted back against the throttling valve. The higher pressure of the accumulator acts against the other side of the throttling valve and the difference between these pressures is dissipated at the orifice formed by the parts of the throttling valve, or by the resistance of the connecting pipes. Speed control (if any) is obtained by adjusting valve opening.

In the volumetric method we are returning part way to the circuit of the simple hydraulic press with its individual plunger pump shown in Fig. 1. The initial pressure in the reservoir of fluid is lower than the pressure reacting from the work to be performed, and a pump is interposed between the reservoir and the motor doing the work, which pump imparts to the working fluid just enough additional pressure to do the work.

Pump Adjustment Regulates Speed

Speed control is obtained by adjusting displacement of the pump while continuing to drive it at a constant rotative speed; this increased pressure is imparted only to enough fluid to drive the motor at the desired speed. No energy is put into the fluid except that which later will be taken out in the form of useful work, plus the friction and a small amount of loss due to leakage. Throttling losses are eliminated. Oil is ordinarily used as the fluid and it acts also as a lubricant for the pump. Properly designed volumetric pumps have long life for these reasons.

The speed regulation is by a definite change in the pump displacement. There is no throttle, and no fluid escapes past a relief valve during normal operation. The leakage in the pump at full load is for one well known make of volumetric approximately 5 per cent of the maximum delivery rate. Changes in load and in viscosity of oil affect only this leakage, not the main part of the flow. The speed regulation therefore is far closer than it is possible to attain with the throttled system.

It may be added here that in the volumetric system even the small departure from the set rate of delivery which occurs when the load changes may be compensated for by a suitable device which increases the stroke of the pump slightly as the pressure rises.

The vital feature of the volumetric system is absence of throttling. Where the positive motor

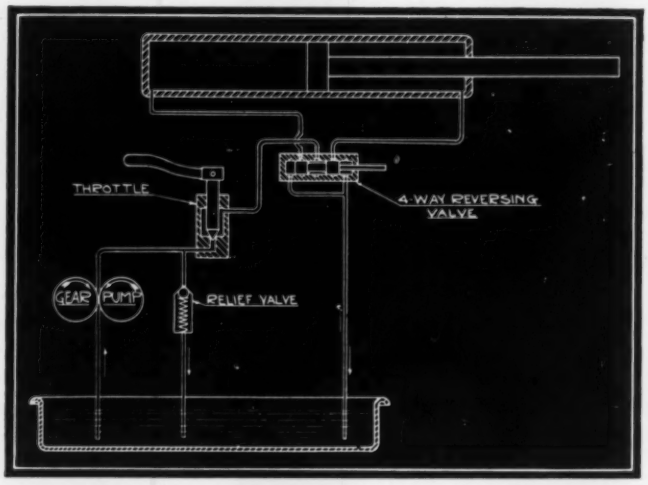


Fig. 7—Constant displacement volumetric pump with relief valve, throttle valve and constant displacement motor

motion feature is not required or not wanted a volumetric pump may be equipped with an automatic control which will increase its stroke whenever the pressure in the line falls below a given value and decrease it when the pressure exceeds this value. Unlike the accumulator system, such a pump delivers a fixed maximum flow and no throttling is required to prevent the motor driven by it from "racing." This method of control is used where it is desired that the motor should stall and exert a given effort without waste of power or undue heating. When the motor is stalled, the pump is running at its rated pressure but at very short stroke, thus consuming practically no power.

System 6 constitutes an important extension of the basic principle of the volumetric system. A variable displacement motor is used in addition to the variable displacement pump. Fig. 6 shows

the units diagrammatically. When the motor is at full stroke its speed may be varied by changing the pump stroke, thus changing the volume of oil delivered to the motor. When the pump stroke is adjusted to its maximum, a further increase in motor speed may be obtained by decreasing the motor stroke. As the motor stroke is decreased and its speed increases, the torque which it can exert decreases. This is a consequence of the fact that the maximum pressure which can be permitted in the system is limited by the strength of the parts and other factors. Thus, when the pump stroke is at its maximum, the motor can deliver a constant power at any speed higher than its full stroke speed. When the pump stroke is decreased, leaving the motor at full stroke, the torque available at the motor remains constant, and the power which can be delivered decreases as the motor speed is decreased.

This system permits the motor speed to be varied even though the rate of delivery of fluid to the motor remains fixed. There are uses where this feature is of importance, as on conveyor drives where one pump may run several motors in series. In this application, the speed of all motors may simultaneously be varied by changing its stroke.

System 7 consists of a constant displacement pump the flow from which is throttled to regulate the amount of fluid delivered to the motor. The difference between the amount pumped and the amount permitted to pass the throttling valve is bypassed through a relief valve. This relief valve is set at a pressure equal to the highest that is required by the motor. No accumulator is used and therefore the pump must be large enough to give a suitable maximum speed when tht throttle is wide open. The waste of power in this system

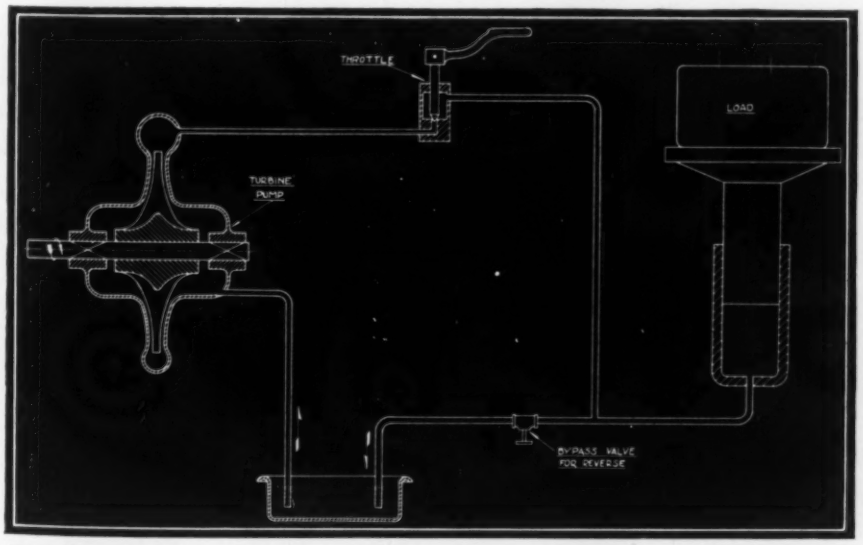


Fig. 8—Turbine pump, throttle valve and constant displacement motor

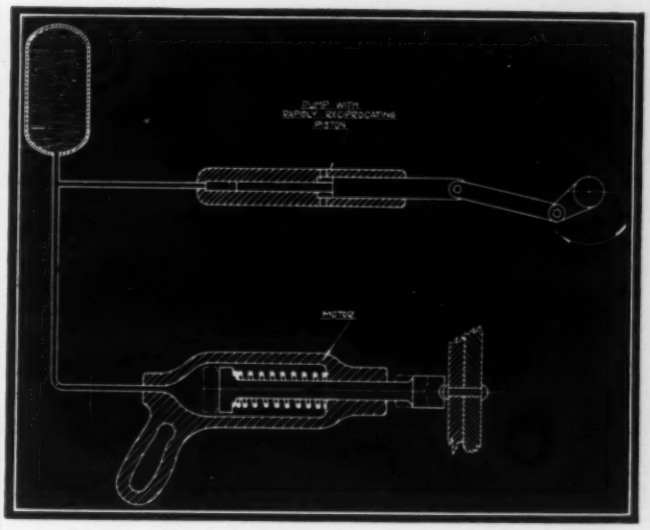


Fig. 9—Alternating impulse pump and motor

is generally of little importance as far as cost is concerned because the power which can be satisfactorily handled in this way is small.

But trouble results because the power lost is converted into heat, which causes great changes in the viscosity of the oil. These changes in oil viscosity cause great changes in the speed of the motor even when it is pulling a constant load, because the motor speed depends upon the rate of flow past the orifice in the throttling valve. As the oil thins out due to heat, more of it gets past the throttle at a given pressure, and vice versa. When, in addition, the load is subject to fluctuation, satisfactory speed regulation is impossible. Every change in load changes the net pressure drop at the throttle valve, and the rate of flow changes so as to accommodate itself to the new load. This system also is inherently unsuitable for high pressures. Due to the smaller volumes of fluid handled in order to transmit a given power, the regulating orifice becomes smaller and more subject to clogging and to changes due to heat expansion. A commercially successful application of this system is on light internal grinders. On such machines the friction on the ways furnishes the greater part of the load and this is fairly constant. Resistance of the work against the wheel is small, and fluctuations in this force do not change by much the total load the motor handles. It is less satisfactory on drilling and boring machines

where the loads encountered and the power required are greater. The chief difficulties arise from changes in oil temperature.

Characteristics of System 8 are about the same as those of System 7 when the latter is operating with the throttle partly closed. As compared with System 7, it has the virtue of requiring no relief valve; when the motor is stalled, no fluid is delivered by the pump.

Experimental Drive for Buses

Fig. 8 shows a turbine pump delivering fluid to a positive displacement motor. If the motor also be of the nonpositive turbine type, the characteristics are somewhat different. This latter combination was used for driving the propellers of a Canadian ocean liner, but has been replaced. The drive is also being experimented with as a transmission for buses and light locomotives. Some arrangements give a motor torque which decreases automatically as its speed increases. This system is quite simple in construction, but its low efficiency has prevented extensive use.

The system shown in Fig. 9 of fluid power transmission is little known. It consists of a pump which causes the fluid in a pipe to oscillate instead of flowing steadily in one direction. A motor plunger picks up the oscillations in the pipe and converts them back into mechanical motion. The pump and motor each may have one plunger, as shown in Fig. 9, or each may have two or more. A chamber full of fluid furnishes capacity for compression; its volume is sufficient to permit the motor to miss a stroke without raising an excessive pressure. This oscillating oil column system, invented by G. Constantinesco, bears to the continuous flow systems described previously about the same relation as the alternating current electric system bears to the direct current system. There is no control of motor speed; the motor must remain in synchronism with the pump.

Plunger Times Firing of Gun

During the war the principle incorporated was developed and used for firing machine guns on airplanes so that the projectiles would pass between the propeller blades. A small plunger pump on the engine was connected by a pipe to a cylinder operating the trigger of the gun. Each stroke of the pump plunger forced a corresponding stroke of the motor plunger, thus timing the firing of the gun. It is stated also that it was used successfully for riveting ships during the war. Inasmuch as the main reason for the use of hydraulics in machine design seems to be in its ability to give comparatively large forces under speed control, it seems unlikely that the field for the oscillating system will be large in the near future.

Hydraulic power transmission will not do everything; it has, like every other art, its limitations. Some of the urgent problems for which hydraulic equipment is needed require units larger than any in existence today. In some cases its use must await the development of smaller units, or the lower costs which will follow wider use. But it is plain that the new devolpments in the art already have radically extended its field. Hydraulics now occupies an important place in machine design. Functions can be obtained which it is difficult or impossible to get in other ways. Its flexibility, its ability to deliver large forces smoothly and the ease with which special design requirements can be met by standard units, all force the conclusion that engineers have in hydraulics a valuable resource.

The next section of this article, to be published in a forthcoming issue, will deal with some practical applications of hydraulic equipment to mechanisms and machines.

Suggests Check on Influence of Acids on Bearing Metal

Developments in bearings and bearing metals formed the subject of a discussion by W. M. Corse, Washington, at a recent meeting of the Philadelphia Foundrymen's Association.

Improvements to the lead-base alloys were outlined by Mr. Corse, some of these improvements consisting in increasing the lead-rich matrix by adding alkali or alkaline earth metals, or in increasing the strength of the other constituents embedded in the matrix by the addition of nickel and cadmium.

In speaking on the subject of lubrication of bearings, stress was laid on the effect of certain constituents of bearing alloys on the lubricant. It was stated that copper, zinc and antimony act catalytically to decompose fatty oils which are especially favorable to lubrication. Knowledge of friction and lubrication shows that thick-film lubrication depends only on forces due to relative motion of metal and lubricant, the only property of the liquid involved being the viscosity, whereas in thin-film lubrication other properties of the lubricant come into play, principally oiliness. The oiliness, and hence the friction, depends greatly on the chemical nature of the lubricant.

It also was pointed out that it would pay to make a general investigation of the influence of fatty acids on different metals, and to determine which acids are harmless and which dangerous.

How To Redesign a Machinery Base for Welded Construction

By E. H. Windle

Mechanical Engineer, Lincoln Electric Co., Cleveland

PRIMARILY, the purpose of a machine base is to hold the machinery to be mounted in proper alignment under operating conditions. The secondary purpose of the base is to provide a rigid mounting so that the machinery may be shipped assembled without danger of having its alignment destroyed. A third consideration is that the base shall be so designed that it may be installed on its foundation and bolted down without having the alignment of the mounted machinery destroyed. These objects must be attained with a minimum cost.

The cast iron base under consideration, in the absence of information to the contrary, may be assumed to meet the requirements stated above in every respect except the matter of cost. Therefore the problem is to reproduce the same stiffness and strength in the steel base about to be designed, which are found in the existing base. No calculations or estimations need to be made of the loading on the base or the material provided to support the loading, since it is assumed at the outset that the cast iron base, under the most severe conditions, is satisfactory for the purpose.

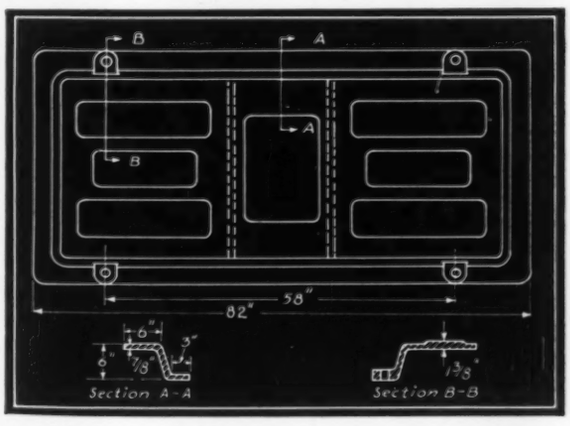


Fig. 1—Original cast iron machine base

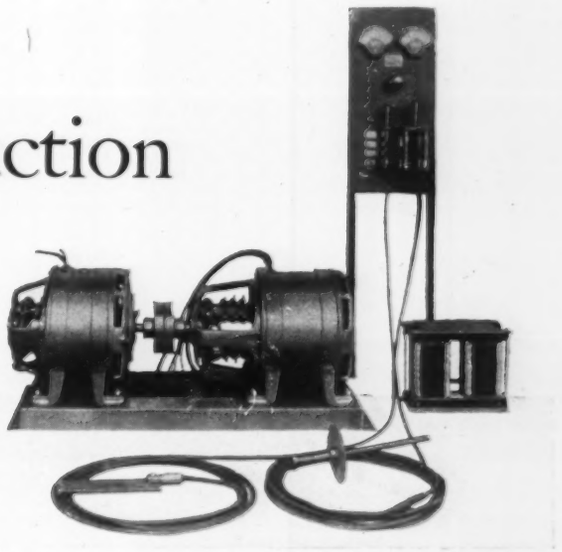


Fig. 2—Typical example of base

To illustrate the simplicity with which the redesign from cast iron to welded steel may be effected, an analysis is herewith presented of a typical case. The technical data are given on the cast iron base merely for purposes of comparison.

Fig. 1, showing the original base, was designed for manufacture in cast iron. Two machines are carried on the base, each weighing 2500 pounds. The center of gravity of each machine is 24 inches from the transverse centerline of the base. It was calculated in the original base design that under the unfavorable condition shown on Fig. 2, the maximum allowable deflection due to the static load on the base should not exceed .008 inch. This is deflection due to the 2500 pound machine standing on the unsupported end of the base and not coupled to the other machine. If the machines were coupled under this condition there would be considerable binding in the bearings. The .008 inch base deflection is taken as the limiting conditon.

With the design shown, and under the conditions stated, the maximum stress at point T is 6000 pounds per square inch. The factor E is taken as 13,500,000.

It is apparent from the drawing on Fig. 2, that if the nuts on the foundation bolts were tightened up the stress would rapidly reach a value at which the base would be broken. The slightest pressure from these nuts will distort the base beyond the set limits. The base is not designed for such pressure in spite of the fact that it is designed in a manner to permit such pressure being applied.

Fig. 3 shows a base of equivalent stiffness made

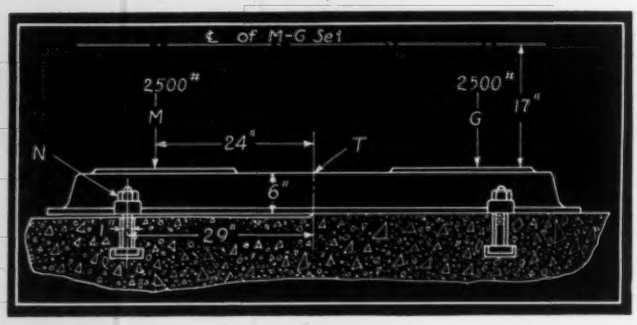


Fig. 3—Elevation of cast base showing how it may be overstressed due to tightening foundation bolts on irregular grouting

of welded steel. The designed size of the angle side members was arrived at in the following manner:

Referring to the cast iron base:

$$D_{max} = \frac{W l^3}{3 E I}$$

in which D_{max}=.008-inch, W=2500 pounds, and E=13.5×10⁶.

Therefore, I=107.6 inches⁴. S=6000 pounds per square inch.

To get the factor I for the steel base, we may solve the same formula substituting the value of E for steel, thus

$$D_{max} = \frac{W l^3}{3 E I}$$

in which D_{max}=.008-inch, W=2500 pounds, and E=30×10⁶.

Therefore I=47.4 inches⁴.

One-half (for each side rail)=23.7, and a 6-inch x 6-inch x ⅝-inch angle has I=24.16.

The weight per foot of the cast iron section at *A-A* is 49 pounds per foot. The weight of the steel angle of same stiffness is 24.2 pounds per foot, thus proving that equal stiffness may be obtained by use of one-half as much steel as cast iron.

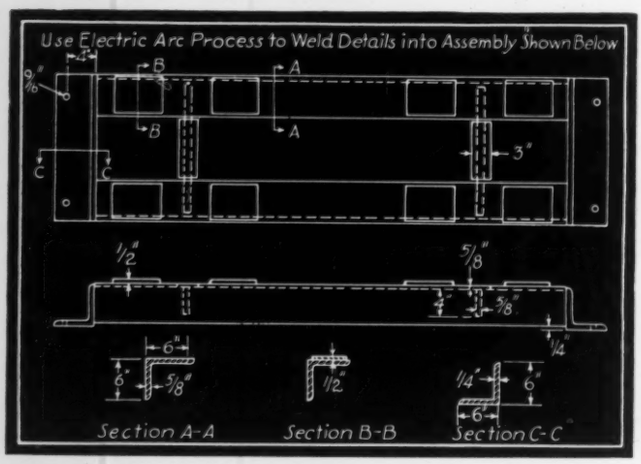


Fig. 4—Base redesigned for welded steel construction, with bolt holes at ends

The steel base has the relatively limber angle at the ends with the holes for foundation bolts near the edge. This design is to eliminate the possibility of distorting the base by tightening the nuts on the foundation bolts. The end angles will flex under pressure rather than the base side rails bend and defective design of the cast iron base thus is corrected in the steel design.

From the discussion given above we can draw up a general statement to be used in redesigning cast iron machinery bases for welded steel construction on the assumption that the cast iron base was satisfactory, mechanically.

> "Replace the cast iron beam sections with steel beam sections of the same depth but with only one-half the weight. Weld the steel beams together to get the shape for the base. Weld steel lugs cut from angle sections to the steel beams and drill the lugs to take foundation bolts. Use steel bar stock for mounting pads. Weld mounting pads where needed on steel beams."

This statement is what may be called a "rule of thumb" method and while it may not give the most efficient design it will in general give a satisfactory one at a very material saving in cost. Its advantage is the elimination of calculations and the resulting rapidity with which a satisfactory design can be evolved.

Engineers Award Belgian Prize

Award of the George Montefiore prize for 1929 has been made to R. D. Evans and C. F. Wagner. engineers of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., in conjunction with three other engineers, Algeri Marino, of Rome, and H. Parodi and Pestarine, of Paris. This triennial prize is presented by the Foundation George Montefiore, of Liege, Belgium, for the best original work contributing to scientific advancement in the technical applications of electricity.

Diesels for Automobiles

Two high-speed heavy oil engines from a line of five introduced recently by Linke-Hofmann-Busch, Breslau, Germany, are intended for automotive work. Of these engines, one is a four-cylinder delivering 50 to 60 brake horsepower and the other a six-cylinder with an output of 80 to 90 brake horsepower. It is claimed that some of these motors, when equipped with aluminum pistons, etc., are capable of attaining engine speeds as high as 3,000 revolutions per minute. At 1200 revolutions per minute the four-cylinder develops 50 horsepower.

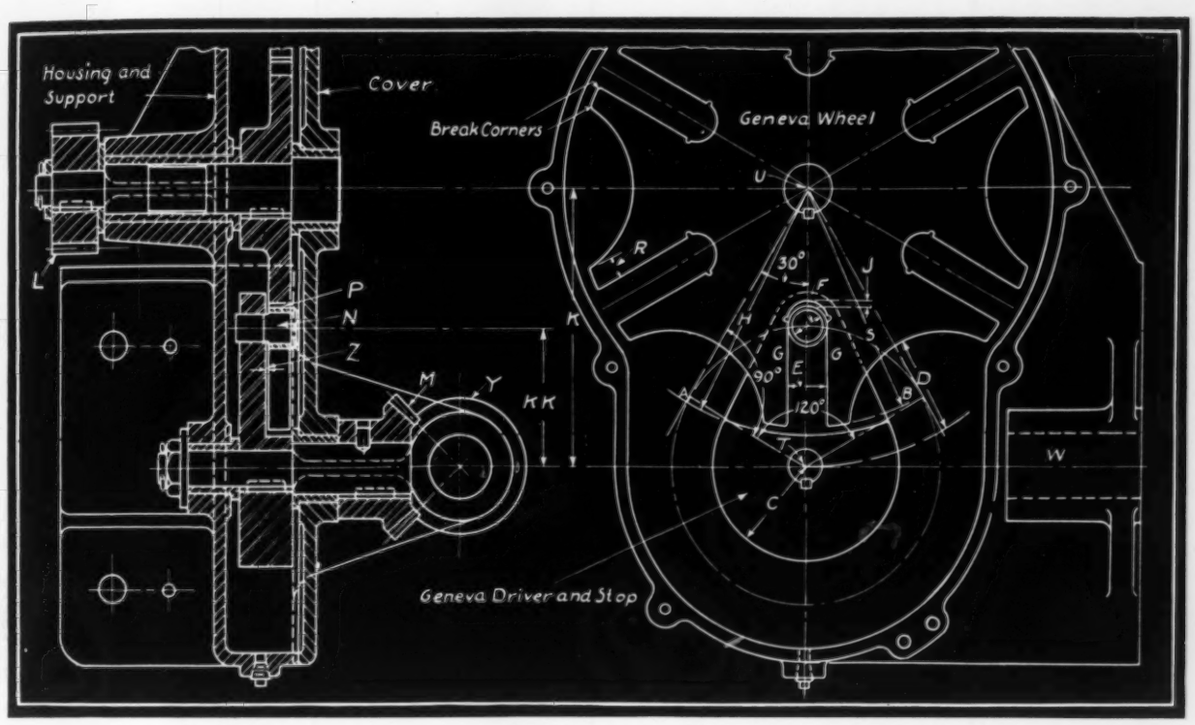


Fig. 1—General arrangement of a geneva wheel indexing mechanism

Geneva Wheel Is Ideal Mechanism for Indexing Movements

By George T. Chapman

A MECHANISM which affords an ideal mechanical movement, for various machines which require an indexing or intermittent motion to either the machine or part thereof, is the geneva.

The principle itself is old, but its use has not been as general as that of some other types of indexing mechanisms which are far more complicated and less efficient.

Some advantages of the geneva wheel are as follows:

1. Acceleration, which is gradual from a state of rest to maximum when movement is half completed, from which point it decreases and becomes gradual as the movement is ended. This will be noted in Fig. 2. Fig. 3 illustrates the method used in arriving at results for plotting curve in Fig. 2. By following such procedure, perfect synchronism may be obtained between the geneva wheel indexing movement and some other member of the machine.

2. Simplicity of design. Five moving parts, including the small roller and two shafts, constitute the working parts of the whole mechanism.

3. Adaptability to lubrication. Permits being housed and consequently can be run in oil.

4. Range of indexing movement. By varying number of slots in geneva wheel or by means of gearing as shown in Fig. 1, any desired movement in the final index may be obtained.

Design of Mechanism Is Simple

For severe and continuous application the writer recommends that the geneva wheel be made of equivalent S. A. E.—1020 steel with S. A. E. heat treatment 1020-1V with the exception that it should first be normalized at 1650 to 1750 Fahr. Should be carburized 1/32-inch deep, in order to provide stock for grinding slots as shown at *G* in Fig. 1.

The designer may determine the number of slots required in the geneva wheel, which will limit the time of operation and dwell thereof during the

complete cycle of the driver; or he may decide between the operating time and dwell of the driver, which will limit the number of slots in the wheel.

The minimum number of slots with which it is possible to operate the geneva wheel is three and the maximum, theoretically, is infinite. The largest number possible in practice would not be great; however, it is doubtful that this limit would seldom, if ever, have to be approached.

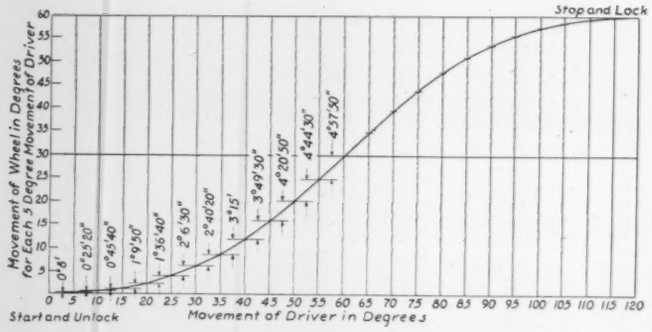

Stop and Lock
Movement of Wheel in Degrees for Each 5 Degree Movement of Driver
Start and Unlock
Movement of Driver in Degrees

Fig. 2—Curve indicates gradual acceleration and deceleration of geneva movement

The 90 degree angle is constant, regardless of the number of slots. The 30 degree angle holds only for the six slots, which give 60 degree movements of the wheel to 120 degree movements of the driver. *A* and *B* indicate points where roller

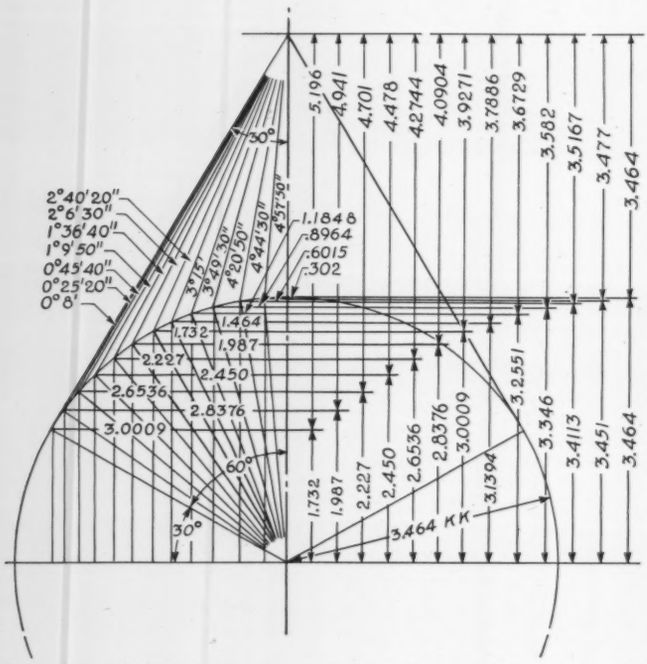


Fig. 3—Method employed for determining points for plotting curve shown in Fig. 2

P enters or leaves wheel. Dimension *D* should be of such proportion as to allow sufficient stock at *R*. *D* equals *C* plus .015-inch when geneva wheel is to be heat treated, otherwise this dimension should be held to *C* plus .005-inch. The quiet operation of the mechanism depends on this clearance and if the dimensions given are exceeded, a slight knock will result. *E* equals *F* plus .008-inch, *H* equals *S* plus .25-inch, *J* equals 1/8-inch. *K* is dependent on size of geneva wheel and represents the hypotenuse of the triangle *A T U*.

Movements Governed by Slots in Wheel

Although the number of slots govern the movement of the geneva wheel, the actual indexing movement of the driven member also can be governed by the ratio between driving gear *L* and the driven gear which makes the actual index movement. *W* represents the bearing for drive shaft on which is mounted bevel gear *Y* and driving bevel gear *M*. Stud *N* and roller *P* should be hardened and ground, grooves being provided to take care of proper lubrication. *Z* should be 1/32-inch and *KK* equals the opposite side of triangle *A T U*.

In 1922 the writer replaced a ratchet form of index on three special machines by a geneva wheel. The machines were used, on the average, eight hours a day for a period of four years or approximately nine thousand six hundred hours. During this time no repairs were made on the indexing mechanism with the exception of replacing one roller, shown by *P* in Fig. 1, whereas the ratchet indexing mechanism used previously required constant attention and repair due to the excessive speed at which it started to accelerate the load.

Hints Research Work Essential

When the ample iron-rich ores in North America, sufficient to last another generation, are depleted vast quantities of lower grade deposits will be available and the growth of our iron and steel industry will not be limited. These were the words of Dr. Zay Jeffries in his address presented at the annual meeting of the American Institute of Mining and Metallurgical Engineers held in New York Feb. 17-21. Progress in mechanical engineering and labor saving processes in the iron and steel industry has been excellent, Dr. Jeffries declared, but in the matter of research to develop new processes, new uses and new materials we have been prone to lean on the work in Europe; more extensive research is one of the great pressing needs in American Industry today. In addition to this need he feels the iron and steel industry is in need of greater standardization of products.

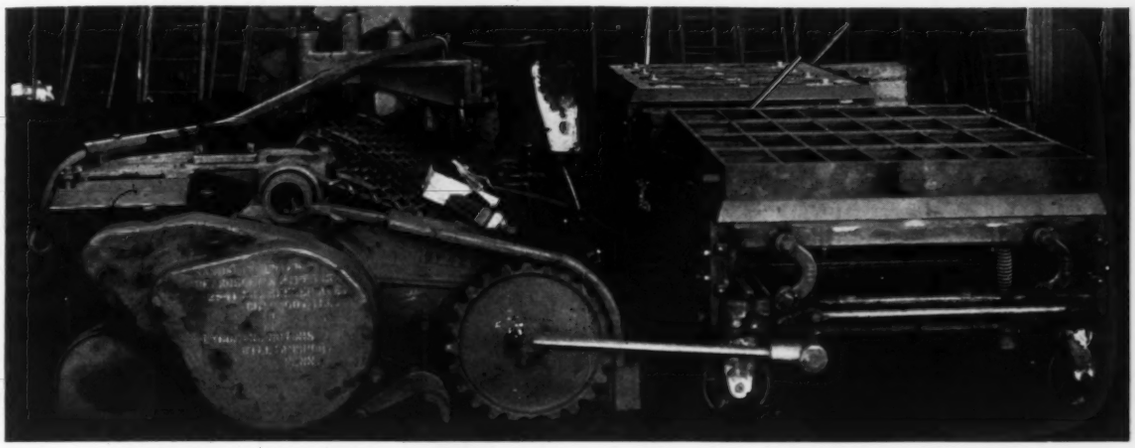


Fig. 1—Casters are used advantageously on molding and other machines in foundry

Trend Toward Portability Increases Use of Casters on Machines

By H. B. Veith

Editorial Representative, Machine Design

PROGRESS in the mechanization of industry has opened new avenues for the application of casters to machines. The trend toward portability, particularly in plants employing assembly lines for mass production, is introducing many and varied uses of this machine part. Advent of casters into this category of the designer's material with which he conceives new machines, enables him to meet new requirements. Not alone does industry find the caster an important machine part, but it also is performing an efficient service in the business and domestic world.

The question: "What must a designer of machines know about casters?" presents itself; therefore a study of this rather simple but necessary unit will be of assistance. The function it performs is vital to the satisfactory operation of the equipment to which it is attached.

Casters are not new. History records their use as far back as the sixteenth century, yet it was not until recent years that they were developed in point of efficiency of operation. The first casters were crude and extremely simple in design. Working parts were easily worn out after short use. Perhaps this deficiency, the consequence of underdevelopment, resulted in delaying the application of casters to machines and heavy equipment.

Then came a revolution in industry and almost simultaneously a step forward in the design and construction of casters. Swivel bearings were provided to reduce the wear of metal-to-metal working parts and many refinements including brakes, rubber-tired wheels and adjustable adapters were added. Special steels and alloys were used to give casters more sturdy construction and enable them to carry heavier loads.

Many Types of Casters Manufactured

Progress has continued until now the manufacturers of casters are able to meet virtually every specification from their regular stocks. One of the larger manufacturers of high grade casters, the Colson Co., Elyria, O., makes nearly 600 types, providing over 1000 different combinations. Wheel diameters range from 1¼ to 10 inches. While its line also includes small casters for various purposes, the units described in this article are the larger types suitable for machine application.

In the employment of casters as a machine part it is interesting to note some of the more recent applications to machines. In foundry equip-

ment casters are especially useful, more particularly in the smaller shops where it is convenient and desirable to move the equipment from place to place. Molding machines have been designed with casters, as shown in Fig. 1. Sand cutters, another piece of foundry equipment, use casters of the larger type illustrated in Fig. 2.

Line Markers Are Fitted with Casters

When traffic became a problem with the improvement of roads throughout the country it was considered necessary to provide lanes to reduce accident hazards. For this task traffic line markers were designed and it was found that casters were better suited for the work than wheels. The ability of the caster to swivel about is a salient feature that gives it superiority over wheels in many cases.

Use of large capacity electric refrigerators is becoming more flexible with the addition of casters. Some of the large metropolitan hotels have employed this means of conveying their

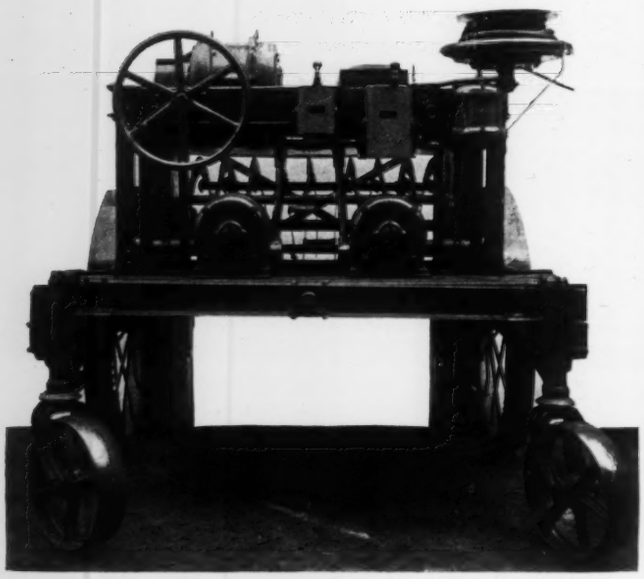


Fig. 2—Sand cutter equipped with large casters is indicative of trend

cooling machines to the banquet halls, thereby serving guests with greater dispatch and better prepared dishes.

The vacuum cleaner for domestic use is fundamentally a caster machine. A suitable caster with a composition wheel has been developed primarily for use on carpets and rugs. It rolls easily and smoothly without a tendency to adhere to the nap. This wheel material was developed after it was discovered that rubber caught the carpet and interfered with the easy operation and movement of the machine. Cleaning machines for industrial use also are equipped with casters.

One of the more recent applications of casters is in talking picture equipment, a part of which is positioned backstage behind the screen. In the larger theatres where it is necessary to raise the screen for stage performances and vaudeville, it is imperative that the horn towers which carry the spoken words and music to the audience be moved at these intervals. Consequently casters

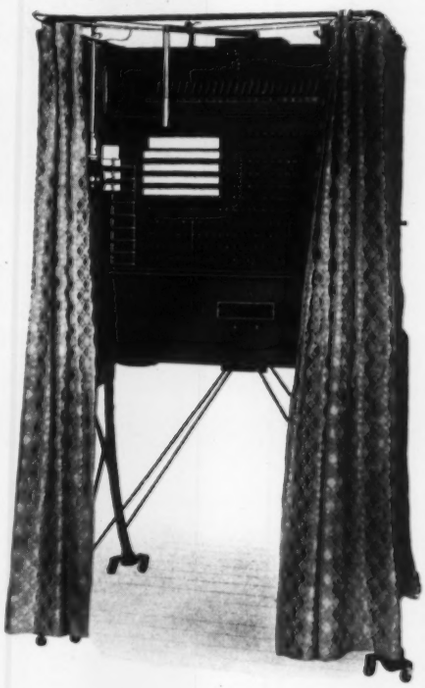


Fig. 3—Use of casters on voting machines is a recent development

were installed on the bases of the horn towers.

Voting machines, another new development, rapidly are coming into use throughout the country. Their infrequent service, however, makes it necessary to move them from storage to stations in the various precincts. To accomplish this the manufacturers have looked to casters and here again this type of movable means has been found successful.

In amusement places portability is an important factor and to give ice cream vending machines this attribute casters have been used in several instances. There are numerous other cases where machines in similar capacities and places could be set on casters to advantage.

Field of Application Is Broadening

Vibrators, X-ray equipment, portable grinders, shop cranes, portable elevators, washing machines, permanent wave machines, victrolas and other units utilize casters. Demands of progress will require the factor of mobility in more machines as times goes on, and in view of this the designer can depend on casters for assistance in solving his problems. At present finishes of casters are

lacquer and enamel, black and blue with some olive green predominating. However, the tendency toward a greater variety of color already has evidenced itself and it is predicted that the time is not far off when more importance will be attached to color. The Colson company recently filled an order for highly polished chrome plated casters. While stainless steel has not been used it is believed this new alloy will become prominent in the industry and will fill a long felt need.

In design and construction casters offer an interesting subject. Fig. 4 shows a light-medium duty caster. It is fitted with either a 3, 4 or 5-inch wheel which may be cast iron, cast alloy or rubber-tired. When rubber tires are used the wheels are made of stamped steel disks bolted together. The tires are demountable. The plate for fastening to a unit is the flat top type. Ball bearings are used and the upper or thrust bearings ride in fully machined raceways which are oil tempered. The load or bearing disk is of the floating type to preserve alignment. Four rivets hold the thrust plate to the fork crown, and lower or radial bearings roll in grooved raceways. Ball or roller bearings for the wheel hub can be furnished.

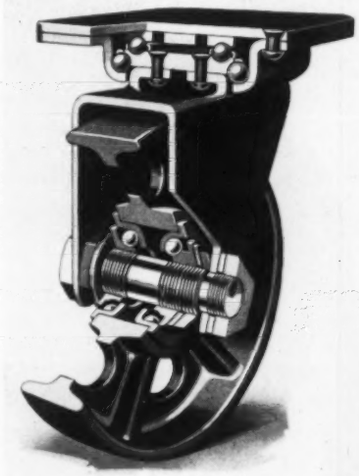
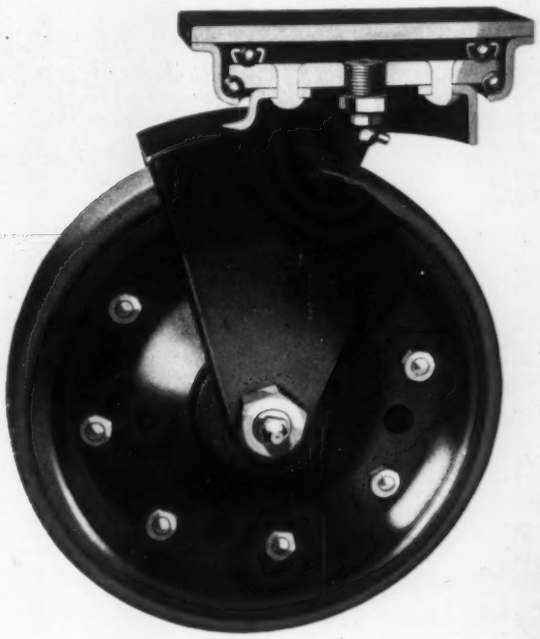


Fig. 4— (Above) —Cutaway section of a light-medium duty caster showing details of construction. Fig. 5— (Right) —Larger type caster equipped for pressure lubrication



Any of the larger type casters can be equipped with pressure lubrication systems. This unique feature is illustrated in Fig. 5 which shows the fitting that supplies grease to the load and thrust bearing. Hub bearings are accommodated by the fixture shown on the axle. This illustration also shows the details of the medium-heavy duty rubber-tired roller bearing swivel caster. Wheels for this type are stamped out of ⅛-inch steel plate and are furnished in 6 or 8-inch sizes. Rubber tires are approximately 2 inches wide on the tread. However, cast alloy or cast iron wheels are available and are recommended where chemicals or other peculiar floor conditions are detrimental to rubber.

Brake Is Notable Feature of Casters

Light-duty brake casters with a drop fork feature have a decided advantage where it is advisable or essential to hold the machine stationary. To set the brake the levers extending outwardly on either side of the wheel are tripped. This places the wheel over dead center, lowering the load directly on the tire, thus locking the wheel swivel.

Fig. 6— (Below) —Caster with adjustable adapter incorporating simple principle. A type of brake also is shown

An adjustable adapter, as shown in Fig. 6, incorporates a simple principle that holds the caster securely to its object, usually of tubular construction. The mechanism shown consists of three parts, an upper cone, lower cone and expanding member. The upper end of the caster stem its threaded to screw into the upper adapter cone, thereby drawing the cone down and forcing the ends of the prongs on the expanding member against the walls of the tube. Another type of brake also is shown in this illustration. It acts on the same principle as the one described heretofore in the text.

The use of casters on machines still is a comparatively new practice but recent installations reveal new opportunities for the consideration of designers.

Calculating the Moment of Inertia of Complex Sections

By John Flodin

Assistant Professor Machine Design, University of Minnesota

IN CALCULATING the moment of inertia of built up beams, or of complex sections which may be broken up into parts equivalent to the members of built up beams, the formula

$$I = A\ d^2 - I_{cg}$$

is used. I is the moment of inertia, in inches^4, about the neutral axis, which is the axis through the center of gravity of the entire section; A is the area in square inches of each individual part or member of the section; d is the distance in inches from the neutral axis to the center of gravity of each member; and I_{cg} is the moment of interia of each member about an axis through its own center of gravity, parallel to the neutral axis of the entire section. The sum of the moments of inertia of all the members, as found by this formula, is the moment of inertia of the entire beam about its neutral axis. Usually, however, the finding of the moment of inertia is merely a step toward finding the section modulus, for it is the section modulus that is directly useful in most strength calculations. Once the moment of inertia is known, the section modulus may be found from $Z=I/C$, where C is the greatest distance from the neutral axis to the extreme fibre of the section being considered.

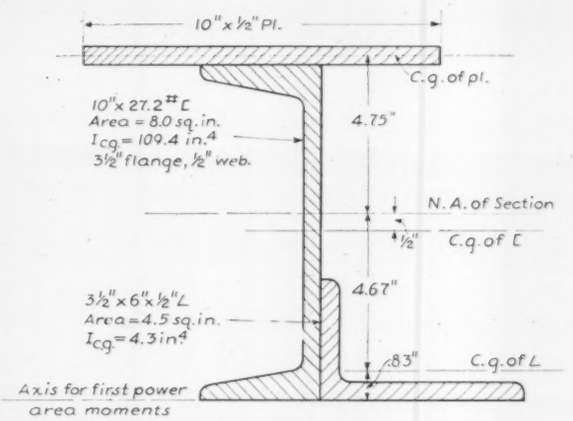


Fig. 1—Section of beam showing dimensions from correct neutral axis

Before the moment of inertia can be found, it is necessary to locate the neutral axis of the section. Since the neutral axis may be assumed to pass through the center of gravity of the section, its location may be found by taking first power area moments about an axis through either extreme of the figure. Dividing the sum of these moments by the total area of the cross-section gives the distance from the assumed axis to the neutral axis of the section. The distances from the neutral axis to the centers of gravity of the various parts of the beam are next found, after which the formula given above may be applied.

These calculations are apt to become tedious, but it is possible to shorten the work materially, as will be explained by means of the following two examples.

Let it be required, for the first example, to find the section modulus of a stiffener or beam to which a plate is riveted or welded, as in Fig. 1. This construction occasionally is used as a built up beam, but it is more common in stiffening flat tank surfaces, etc. The steel plate is assumed properly fastened to the beam, so that it bends with the beam and therefore contributes to the section modulus. If the plate covers several beams or stiffeners, as in tank work, it is a mooted question how wide a strip of plating one should include in the section modulus. Some specifications make the width of the strip 20 or even 40 times the thickness of the plate; others (notably the United States navy) permit the assumption that the section modulus is augmented by a strip of plating whose width is three times that of the supporting flange.

In the figure, the flange of the channel is 3½ inches wide. Using the United States navy rule, a 10½-inch strip of plating may be included in the calculations for the section modulus of the beam. Including such a strip in the calculations would cause the neutral axis of the section to move to some position near the upper flange of the channel, which would be uneconomical because it would give an unreasonably large value for C

in the formula $Z=I/C$. To correct this undesirable condition the lower part of the channel is reinforced by means of an angle, as shown, the angle being selected to bring the neutral axis near the mid-depth of the figure, but not necessarily quite to the mid-depth line.

Calculating the Section Modulus

Ordinarily the calculation for the section modulus is performed as follows. The neutral axis is first located by means of Table I. In the first column of this table the three members of the beam are listed, and in the second column are given the corresponding areas. The third column contains the distances from an assumed reference axis to the centers of gravity of the members, the reference axis in this case having been taken at the bottom of the figure (the line marked "Axis for first power area moments" in Fig. 1). In the last column of the table are written the products of the corresponding distances and areas, or the first power area moments. The sum of these moments is 97.54, and the sum of the areas is 17.75, giving a quotient of 5.5 inches, which is the distance from the assumed reference axis to the neutral axis of the section.

Next the distances from the neutral axis to the centers of gravity of the members are found, these values being indicated in Fig. 1 and entered in the third column of Table II. The first two columns of this table are identical with those of Table I. Column 4 gives the "four-square moments," or the values for d^2A found from columns 2 and 3 by simple multiplication. In the fifth column are entered the moments of inertia of the various members about their own centers of gravity, these quantities being taken from handbooks, as are also the distances from the centers

Table I

Calculations for the Neutral Axis for Beam Shown in Fig. 1

1 Member	2 Area A	3 Distance d	4 Area Moment dA
Angle	4.50	0.83	3.73
Channel	8.00	5.00	40.00
Plate	5.25	10.25	53.81
	17.75		97.54

Distance from assumed axis to neutral axis of section

$$= v = \frac{97.54}{17.75} = 5.5 \text{ inches}$$

of gravity to the heels of angles and other similar shapes.

The moment of inertia of the entire section is, from the principle expressed by the fundamental formula, the sum of all the values in the fourth and fifth columns, or 332.2 inches^4, and the section modulus is 332.2÷5.5, or 60.3 inches^3.

As a first step toward the elimination of useless labor, we may well combine the two tables, the first two columns being identical. But we may go further than this. For reasons that will be made clear later, we may locate the first assumed axis

Table II

Calculations for the Section Modulus for Beam Shown in Fig. 1

1 Member	2 Area A	3 Distance d	4 Moment d^2A	5 I_{cg}
Angle	4.50	4.67	98.0	4.3
Channel	8.00	0.50	2.0	109.4
Plate	5.25	4.75	118.5	0.0
			218.5	113.7

$$I = \frac{113.7}{332.2}$$

$$\frac{I}{C} = \frac{332.2}{5.5} = 60.3 = Z$$

of reference about where we believe the neutral axis should be. If the assumed axis is located so that the distance from both the extremes of the figure are made whole numbers or convenient fractions, the finding of distances from this axis to the various centers of gravity will be made somewhat easier. Taking this assumed axis 6 inches above the bottom line of the figure gives the distances shown in Fig. 2.

The calculations based on these magnitudes are given in Table III. Note that the table is divided horizontally into two parts. The reason for this is that since some of the distances from the assumed axis to the members are measured upward while others are measured down, some of the first power moments become positive, the others negative. It makes no difference which we regard as positive and which as negative, but the positive moments and the negative moments must be added up separately so that the arithmetic difference between the sums may be found.

Column Headings Convey Clear Meaning

The headings of the columns in Table III should make clear the significance of the figures they contain. If a slide rule is used in finding the moments, it is most convenient to multiply the area by its distance, to write down the product in the dA column, and, often without resetting the slide rule, to multiply a second time by the distance, which gives the d^2A value, or second power moment.

The sum of the d^2A moments plus the sum of the moments of inertia of the various members about their own centers of gravity gives the

moment of inertia of the entire section about the assumed axis. This moment, which is 336.9 inches^4, now must be corrected to get the moment of inertia about the axis through the center of gravity of the section.

It was for the purpose of finding the location of the true neutral axis that the table was broken

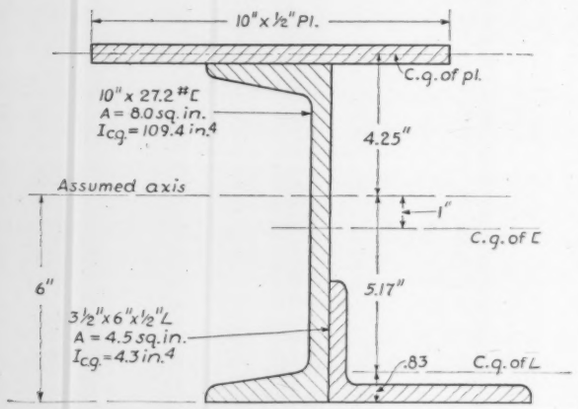


Fig. 2—Section of beam showing dimensions from assumed neutral axis

up into two parts, as already explained. The distance from any assumed axis to the center of gravity of the figure is the quotient of the sum of all the first power area moments divided by the total area. In this case the sum of the area moments below the assumed axis is 31.28, and above that axis, 22.33, giving a net area moment of 31.28—22.33, or 8.95. Dividing this quantity by the area gives 8.95÷17.75=0.5-inch, which is the distance from the assumed axis to the axis through the center of gravity of the entire section, and this distance is in the direction of the larger of the partial sums of area moments, or downward in the figure. This makes the distance from the bottom of the figure to the neutral axis 5.5 inches, as before.

Since $I=Ad^2+I_{cg}$, $I_{cg}=I-Ad^2$. I_{cg}, which is what we seek, becomes therefore in our case $336.9-17.75\times(0.5)^2=332.5$ inches^4. The section modulus then becomes $Z=332.5-5.5=60.4$ inches^3. These values correspond to $I=332.2$ and $Z=60.3$ found by the longer method, the discrepancy being due to the dropping of decimals.

Another Example of Shorter Method

For the second example consider the beam shown in Fig. 3. This is an ordinary structural beam modified by eliminating one of the lower flange angles and cutting away that part of the flange plate directly below the removed angle. In order partly to compensate for the loss of strength due to removing the angle and part of the flange plate, the remaining bottom angle and the remaining part of the plate have been increased in thickness. The resulting section therefore is assymmetrical and it is desired to find its section modulus.

Setting up the work for Fig. 3 as done in conjunction with Fig. 2 results in Table IV. The assumed axis has here been taken at midheight of the figure, so that the distance from this axis to the center of gravity of the web plate becomes zero. Both the first and the second power moments for the web plate therefore become zero. This gives a vacant line in the first power moment column, which is used for the sum of the moments above that line, thus obviating the necessity for actually dividing the table into two parts.

Two Angles Included in Figures

It should be noted that the fourth item listed in the table consists of two items, namely, the two upper flange angles, so that the area given, 9.5 square inches, is twice the area of the individual angles. As a short cut in adding, the sum of the moments of inertia given in the extreme right hand column is written at the bottom of the d^2A column before the latter column is added up, so that the figure 7266.66 is the moment of inertia of the section about the assumed axis. The calculations for the moment of inertia and the section modulus about the true axis, which are given at the bottom of the table, should be clear on the basis of the explanation given in connection with the first example.

Table III

Calculations for Neutral Axis and Section Modulus for Beam Shown in Fig. 2

1	2	3	4	5	6
Member	Area A	Distance d	Area Moment dA	Second Power Moment d^2A	I_{cg}
Angle...	4.50	5.17	23.28	120.4	4.3
Channel.	8.00	1.00	8.00	8.0	109.4
			31.28		
Plate...	5.25	4.25	22.33	94.8	0.0
	17.75		31.28	223.2	113.7
			22.33	113.7	
			8.95	336.9	

Distance between assumed and neutral axes $= \frac{8.95}{17.75} = .50$ in.

$I = 336.9 - .5^2 \times 17.75 = 332.5$ inches^4

$Z = \frac{332.5}{5.5} = 60.4$ inches^3

A study of the table will show that by this method the total work necessary for finding the location of the neutral axis and for determining

the moment of inertia is but slightly greater than the work necessary by the ordinary method for finding the moment of inertia alone, after the neutral axis has been located. In other words, the shorter method eliminates nearly all the work for finding the neutral axis.

Assuming Neutral Axis Is Convenience

Placing the assumed axis about where we expect the neutral axis to fall is particularly convenient when the construction is refined enough to warrant correcting for the effect of rivet holes, or similar losses of strength. If for example the beam shown in Fig. 3 is stiffened by means of vertical angles, there must be a vertical row of rivets in the web plate. Also, there must be rivets connecting the flange angles to the web plate, and more rivets connecting the flange plate to the flange angles. Since properly driven rivets fill their holes completely, no allowance for loss of strength due to rivet holes need be made on the compression side of the neutral axis, while correction is made for the holes in the tension side of the beam. A similar situation of weakening one side of the beam only often arises when a hole has to be cut through the web plate to permit a pipe line to be installed where it will not be in the way.

When it is desired to correct for rivet holes

Table IV

Calculations for Neutral Axis and Section Modulus for Beam Shown in Fig. 3.

Member	Area	Distance	Area Moment dA	Second Power Moment d^2A	I_{cg}
Lower Fl. Plate....	5.00	15.56	77.80	1210.57	....
Lower Fl. Angle....	6.15	14.50	89.18	1293.04	5.0
Web Plate..	15.00	0.0	166.98		1125.0
Upper Angles...	9.50	14.26	135.47	1938.70	12.6
Upper Plate	7.00	15.50	108.50	1681.75	.....
	42.65		243.97	1142.6	1142.6
			166.98		
			76.99	7266.66	

Distance between assumed and neutral axes $= \frac{76.99}{42.65} = 1.81$ inches

$$I = 7266.66 - (1.81)^2 \times 42.65 = 7126.91 \text{ inches}^4$$

$$C = 15.25 - .625 - 1.81 = 17.685 \text{ inches}$$

$$Z = \frac{7126.91}{17.69} = 403 \text{ inches}^3$$

in large beams, the labor sometimes becomes tedious if the area of the metal lost at each rivet is taken independently and its moments deducted. It is much easier and almost as accurate to deduct the lost area from each member before the areas are entered in the table. Thus if a ¾-inch x 16-inch flange plate has holes for two 1-inch rivets, the lost area becomes 2 x ¾ x 1-1/16 (the diameter of the holes being 1/16 larger than the nominal rivet diameter), or 1.59 square inches. The net area of the plate there-

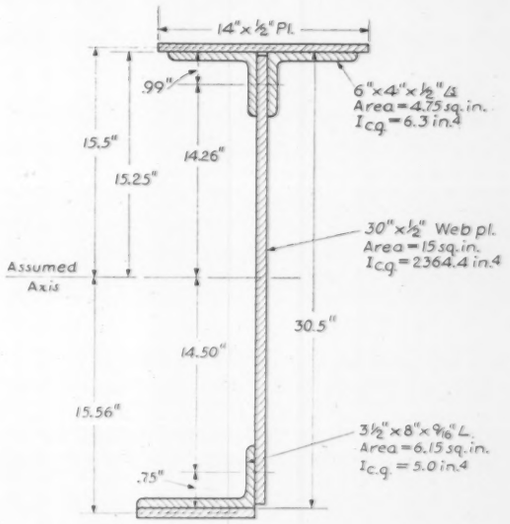


Fig. 3—Section of beam with assumed axis at mid-depth

fore becomes 10.41 instead of 12 square inches. In the case of angles, the net area may be found in the same manner as for plates, and the moment of inertia of the angle about its own center of gravity may be taken as the moment of inertia of an angle of the same leg dimensions but having an area nearest the net area of the angle used, as listed in the steel company handbooks.

Considering Reduction of Plate Area

The same idea may be used with the web plate. Dividing the web plate into two parts at the neutral axis, we may use the full thickness of the plate for the compression side of the beam, but for the weakened side a thickness reduced in proportion to the reduction of area. In applying the formula for the moment of inertia of the weakened part of the web plate about its own center of gravity, that is, the formula $I = th^3/12$, the net thickness should be used for the value entered in the I_{cg} column, just as the net area is entered in the area column.

In the article "Valve Mechanism Is Radical Feature in Cadillac V-16" which appeared in the February issue, the valves referred to in the first paragraph on page 29 were stated to have a diameter of 15/16-inch. This should have read 1-5/16-inch.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Raising Strength by Cold Working

EDITOR'S NOTE: *The following letter, as well as that by Mr. Williams on page 51 of the February issue, refers to the article "Study of Fatigue of Metals Yields Data for Machine Design" by Professor H. F. Moore, which appeared on page 35 of the November issue of* MACHINE DESIGN.

To the Editor:

I READ with much interest the letter in the February issue of MACHINE DESIGN entitled "Raising Strength by Cold Working," by Mr. C. G. Williams.

The writer agrees with Mr. Williams that the word *continued* might well be put before the word *overstress* in my original article. I cannot agree that it would be better to designate "endurance limit" as the "ultimate elastic limit."

All of our observations indicate that the phenomenon of elastic failure is radically different from the progressive fracture which constitutes fatigue failure. We have examined a great many fractured fatigue pieces as well as a good many pieces during the process of fracture. For a careful examination of one such case I would refer to bulletin 176 of the engineering experiment station, University of Illinois, which discusses such a failure in copper. There also is now in press bulletin 208, from the same station, which discusses elastic and fatigue failures in a number of metals.

In most metals slip lines appear before a fatigue crack starts but in some metals, notably in duralumin, we have been unable to develop slip lines until *after* a fatigue crack had started. We do not feel that a fatigue failure should be thought of as an elastic failure but as a spreading fracture.

The proposition to make experiments with a short period of overstress followed by understress sounds interesting and it would seem quite probable that the raising or the lowering of the endurance limit would depend upon the magnitude and number of applications of both series of stresses.

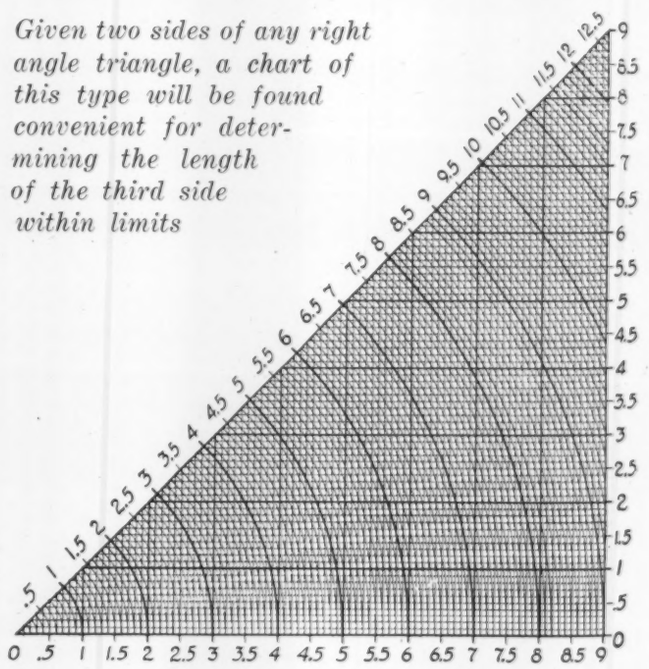
I wish to commend as a concise statement of our present knowledge about the effect of overstresses the closing clause in Mr. William's letter: "should the piece be too strongly stressed small surface checks may be opened up that will later cause failure of the piece."

—PROFESSOR H. F. MOORE,
Urbana, Ill.

Obtaining Sides of a Triangle

To the Editor:

FIGURING a right triangle is an every day job in the engineering department. Much time can be saved by referring to a chart as shown. The chart is made on cross section tracing cloth (or ordinary tracing cloth can be ruled) so that blueprint copies may be distributed. From the lower left hand corner, circular arcs are drawn from the base to a 45 degree line. The three sets of lines represent a scale in units and tenths.



Given two sides of any right angle triangle, a chart of this type will be found convenient for determining the length of the third side within limits

Having two sides of a triangle given, the hy-

potenuse can be found readily by referring to the chart. For example, if the base and height of a triangle are known to be 5.9 and 4.3 respectively, follow up the 5.9 line along the base of the chart in a vertical direction until it intersects with the horizontal line representing 4.3. Then by following the arc nearest this intersection to the 45 degree line the hypotenuse may be read direct, which in this case happens to be 7.3. The larger dimension of the triangle is always taken along the base of the chart. When the hypotenuse and one side of a triangle are given, the unknown side may be found by using the chart in the reverse operation. Follow the arc representing the hypotenuse down until it intersects with the other known dimension and drop down to the base of the chart to read the unknown dimension.

—H. STERLING,
Philadelphia.

Best Design Is the Simplest

To the Editor:

DESIGN of a mechanism never attains the highest degree of perfection unless it is simple in its construction and operation. Some mechanisms involve so many functions that the combination must of necessity appear complex at first hand, but in a good design the functions or operations can be broken down into a series of simple movements or parts. So it is an axiom of good design that to be the best attainable for a given purpose, it must be simple.

An effective way of keeping this truism before the designer is by the use of a series of blueprints or photographs, tracing the evolution of certain designs. These should be framed and placed on the walls of the drafting room. The first attempt at the design, whether it has been built or is only a study, with a clear statement of the problem or requirements, is number one in the series. Successive attempts should range alongside, until the last of the series closes the exhibit, this being a photograph of the part or parts actually in production.

Several sets of such exhibits will be amazing to those who carry out the undertaking, for it is remarkable how a design will simplify itself after the first complicated attempt. If costs are included the exhibit can be made even more instructive.

The effect of such an exhibit on the minds of designers is gratifying, the elimination of complexities being unfolded before their eyes as a fact. Thus they are bound to have a conception of design based on simplicity that cannot help but reflect itself in their work to the betterment of the company's product.

—GEORGE H. GUNN,
Philadelphia.

Should It Be Draftsman or Ingenieur?

To the Editor:

IN 1893 I went to England for a tour through the industrial sections. To the head of the first plant I wanted to see, I introduced myself as an "engineer," from Germany. "Oh, you run a locomotive," he said condescendingly. "Why, no," I replied much astonished, for locomotive tenders as they were called on the continent, socially were not considered to be gentlemen. In my poor English I tried to convey to the Englishman my meaning of an engineer. "Oh, then you are a draftsman!" Again I was puzzled, because a draftsman on the continent means either a tracer or a commercial artist. Finally I learned that in England the men who at that time made mechanical drawings started their vocation as apprentices in a drafting department. No technical education was required, and designing of machines was done by rule of thumb.

I learned also that the word "engineer" is derived from the word "engine," and not from the Latin "ingenium" (intellect) which is the root of the continental "ingenieur."

Contrary to the English custom the continental Europeans trained their budding ingenieurs very carefully in technical colleges. In Germany for example, there were 12 state technical colleges besides numerous municipal and private technical high schools. Zurich in Switzerland had a famous technical college, and also the Italians and French had technical schools of high standing. The entrance requirements were rather severe and German schools even demanded that the student had completed an apprenticeship in a machine shop.

Twenty-five years ago upon entering the United States I found similar conditions here as had existed in England. An engineer was a man who tended a steam engine, whether locomobile or stationary. The men who sat hump-backed over their boards were draftsmen and were treated as such. Of technical schools there were few, and mostly insignificant. Of course there were quite a few designing engineers, but they were mostly Germans, Swiss and Swedes, the Americans preferring active work in the shop.

Later, large manufacturers found they could

(*Concluded on Page* 53)

MACHINE DESIGN

Save Men; Spend Machines

Editorial

SO MUCH misleading information on the roles of machinery in modern American life has been disseminated that it is refreshing to read the rational argument presented by Ernest F. DuBrul, general manager, National Machine Tool Builders' association before the recent meeting of the American Management association in Chicago.

AFTER effectively refuting critics of the machine age, including H. G. Wells, Andre Siegfried, Senators King of Utah and Wagner of New York, and others, he turns to the subject of obsolescence. He asserts that the large number of obsolete machines in use in American industry is evidence that many managements have not adjusted their minds to the philosophy of the machine age. This philosophy, according to Mr. DuBrul, is expressed in the words "Save the man and spend the machine." Every obsolete machine, he declares, indicates partial adherence to the contrary philosophy which says "Save the machine and spend the man."

MR. DuBRUL'S indictment undoubtedly is directed toward users of machine tools, but it applies with equal force to every user of industrial machinery. The subject is of particular interest to the machine design profession because the widespread use of obsolete machinery is a serious deterrent to progress in design. As stated before in these columns, engineering activity in the development of new ideas cannot proceed far beyond the ability of industry to absorb the machines on which they are applied. As it is, many meritorious designs now are awaiting the time when the consuming industries will be ready to utilize them.

THIS capacity of machinery users to absorb new equipment is an uncertain quantity. In many cases it is governed largely by the attitude of management. Therefore, since it frequently is a mental rather than a physical or economic limitation, it would seem that the procedure for engineers who desire to hurdle the obstacle of obsolescence is to offer designs so attractive and appealing that the potential users will be tempted to substitute them for the obsolete ones in their plants.

APPARENTLY the automotive industry already is working on this theory. Its engineering spokesman, Charles F. Kettering, has reiterated on numerous occasions his now familiar doctrine that the job of the designer is to keep the user dissatisfied. While this method probably has greater possibilities in the automobile field than in the realm of industrial machinery, it is certain that the best attack on obsolescence by engineers is by designing so well that the prospective purchasers will be convinced they cannot afford to continue with obsolete equipment. By thus encouraging industry to "spend machines," they will help to "save men."

Back To Fundamentals

NOT long ago our attention was called to a machine on which a 2½-inch shaft 6 feet long, revolving in bearings at each end, was causing considerable trouble because of excessive vibration and sag between supports. It was not possible to introduce an intermediate bearing, but an easy remedy was found in substituting a piece of seamless steel tubing for the solid shaft. Whenever a case of this kind involving a simple principle of design is encountered in machines built by reputable concerns of long experience, we are more than ever reassured of the soundness of MACHINE DESIGN'S editorial policy which provides for one or more articles in each issue on the fundamentals of design. While it is probable that the younger engineers will profit most from the discussions by Professors Martenis, Ault and Flodin, it is not unlikely that older members of the profession will find it advantageous to renew their acquaintance with important elementary concepts of mechanics.

Trial Trip of Robert Fulton's "Clermont"

Great Moments in Machine Design—Seventh of a series of original drawings prepared exclusively for this magazine symbolizing the designer's contributions to the progress of mankind

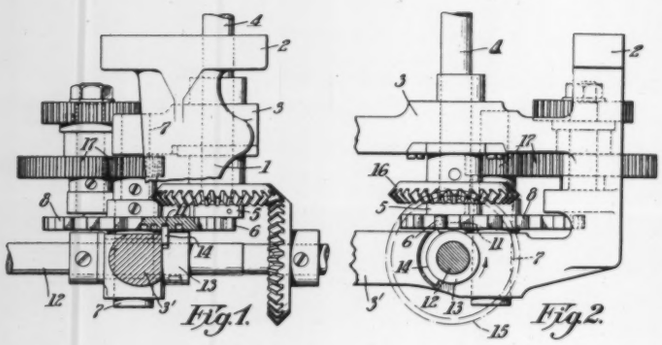
NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining To Design

AN INTERESTING mechanism closely related to the geneva movement recently was patented by Edward B. Allen, Newton, Conn., its inventor. The Singer Mfg. Co., Elizabeth, N. J. is the assignee. According to the inventor the new mechanism provides a simple, easily constructed, quiet running mechanical movement for converting a continuous rotary motion into a step-by-step or intermittent motion with relatively long periods of rest during which the intermittently rotated part is locked against movement. The patent number for the invention is 1,743,511.

A star wheel 8 having a toothed periphery with which meshes a driving pin 6 on a continuously rotating shaft 4 provides the intermittent drive as shown in the accompanying illustrations. To lock the star wheel while the drive pin is out of engagement therewith, a second shaft 12 running with the first shaft is provided. This second shaft has a rib 14 which engages a series of grooves milled in one side of the star wheel and equal in number to the teeth in it. These grooves 11 are cut in a zone within the circle of the bases of teeth.

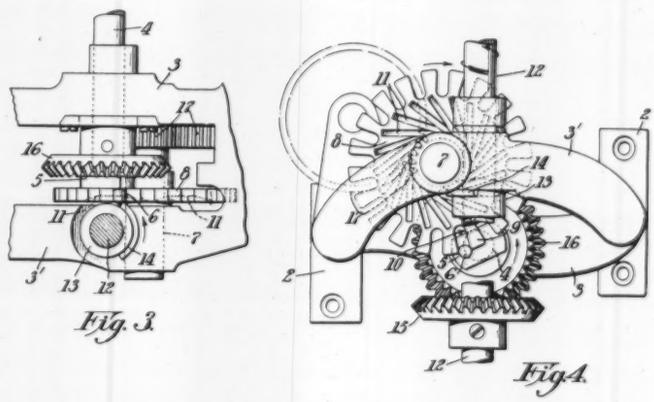
The shaft 12 extending parallel to and also adjacent to the milled side of the star wheel carries a collar having a locking rib timed to enter one of the slots and lock the star wheel



Side and end views of mechanism are shown in Figs. 1 and 2, respectively. Locking rib is leaving groove in star wheel in the latter view

as the driving pin is emerging from driving engagement with the wheel. Since the pin picks up the wheel with an easy accelerating motion and then slows it down, finally bringing it fully to rest before the locking rib enters the slot in the star wheel, there is no danger of the star wheel over-shooting under its momentum.

A bevel gear 15 fixed to the shaft 12 meshes



The driving pin is emerging from driving relation in Fig. 3. Parts are timed the same in Fig. 4, which is a bottom plan view

with the gear 16 which is on the shaft 4, whereby the shafts run in one-to-one relation. Shaft 12 is journaled in frame member 3^1 and is disposed in right angles to the shafts 4 and 7, or parallel to and adjacent to the milled side face of star wheel 8. Intermittent motion of the star wheel 8 is transmitted to the shaft 7 from which it may be applied, as by gearing 17, to the use desired.

FLUID-TIGHT seals to prevent leakage around shafts are particularly important in the design of compressor pumps used in refrigerating apparatus. An invention providing a shaft bearing and seal through which no high pressure fluid is allowed to escape recently was awarded patent No. 1,746,068. The inventor, Eugene L. Barnes, Buffalo, N. Y., has assigned his patent to the Barber Asphalt Co., Philadelphia.

Combining the parts of a shaft bearing and seal in a compact assemblage is not limited to refrigerating systems but has numerous other

applications, according to the inventor. Referring to Fig. 1 the seal is shown as an integral

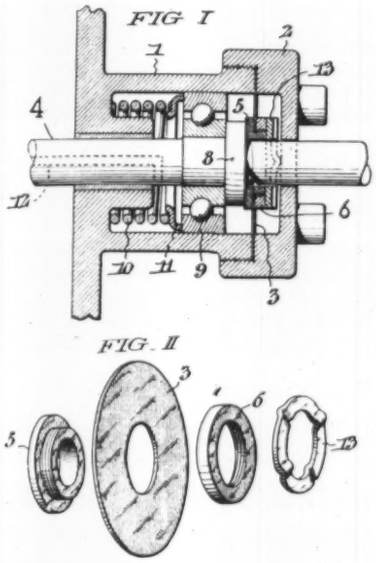


Fig. 1—Details of the fluid-tight seal which provides means for compensating thrust and vibration. Fig. 2 is a perspective view of the bushing, diaphragm, retaining nut and wabble washer

part of a pump chamber, the cup flange 1 being a section of the pump casing. Between the housing members 1 and 2 a flexible diaphragm 3 is interposed, the latter having a central opening through which passes shaft 4 and bushing 5.

Diaphragm 3 is subject to fluid pressure from the interior of the housing. Collar 8 on the drive shaft 4 engages with the bushing 5, forming at this point a pressure seal. Shaft 4 is journaled in the ball bearing 9, the housing for which is held in place by a helical spring 10 and washer 11. Interposed between the bushing 5 and the cap-piece 2 is a washer 13 which offsets projecting outward from opposite sides. Because of its construction the wabble washer 13 adapts itself positionally to any tilt of the contacting surfaces at the sealing point induced by flexure of the right-hand portion of the shaft 4 under centrifugal action.

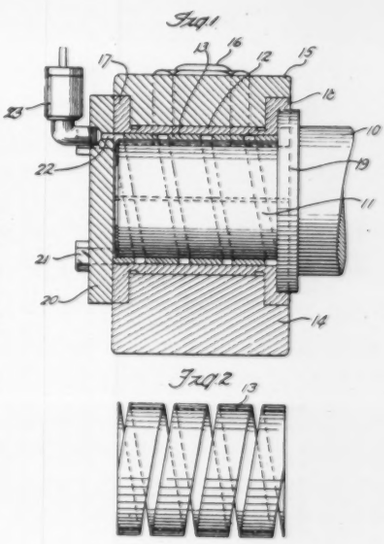
BEARING construction conceived to provide efficiency of lubrication and to facilitate replacement of worn bushings has been patented by Seth Johnson, New Haven, Conn., and assigned to the Safety Car Heating & Lighting Co., New York. The number of the patent is 1,745,425. Fig. 1 of the accompanying illustration shows a shaft 10 having an end journal 11 which is supported in the bearing. Comprising the bearing is a shell 12, into the cylindrical interior of which is fitted a bushing 13 made from suitable bearing metal.

Bushing 13 shown in Fig. 2 is in the form of a helical strip with a normal outer diameter larger than the inside diameter of shell 12, and is contracted slightly when placed within the shell. The space between the coils forms a path by means of which lubricant may be distributed to all parts of the bearing.

By loosening the bolts 16 and removing the cap 15 the shell 12 may be lifted out of the support 14 and slid off the end of the journal 11. Lubrication is admitted to the bearing through the passage 22 which is connected with the grease cup 23. The inventor claims that this bearing construction is of particular advantage for supporting an oscillating shaft, such as the suspension shaft of a pivotally suspended generator in car lighting equipment. An oscillating shaft or journal of this type rotates through a small angle and it ordinarily is difficult to lubricate the bearings properly.

IN THE invention of a ball and socket joint for which John I. Muncy, Detroit, recently was granted patent No. 1,745,704, the principal object is to provide a connection that will not require lubrication. Studebaker Corp., South Bend, Ind., has been made the assignee. This invention provides a ball and socket connection in which there is no metal-to-metal contact of the wearing parts. Bearing surfaces of the sockets are formed of a fabric impregnated with graphite.

The conventional form of an automobile drag link end, to which the invention is adapted, is shown in the illustration on page 52. Mechanism for the ball socket is comprised of a plug 12 which seats against the shoulder formed at the point where the end portion 11 is expanded from the body 10, and which is provided with

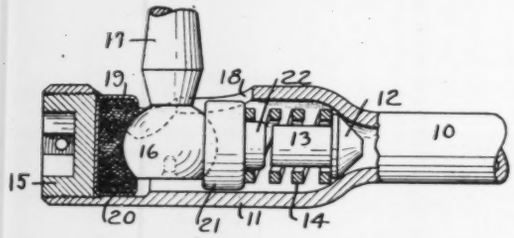


A spiral is formed with coils to provide a bearing bushing as shown in Fig. 1. Fig. 2 illustrates its construction and the space between the coils through which the oil circulates

an extended end 13. A coil spring 14 is guided over the end 13 of the plug 12.

Two ball seats incorporating the invention and provided with oppositely opposed bearing surfaces

are inserted in the end 11 and are followed by a threaded plug 15. A ball 16 on the end of shaft 17 is inserted through the opening 18 and positioned between the oppositely opposed faces of the ball seats. Plug 15 screws up until



Ball and socket joint with the bearing surfaces of the socket formed of fabric impregnated with graphite

the spring 14 is compressed, thereby holding the ball 16 and allowing universal movement of the shaft 17 within the limits of the opening 18.

Bearing portion 20 is composed of fabric, preferably interwoven with soft metallic threads, such as copper, bronze or the like, and heavily impregnated with graphite. By hydraulically compressing it to form a hard solid body and machining if necessary, it may then be inserted in the shell 19 and the edges of the shell spun over to hold it in place. The spherical depression for the ball 16 then may be formed in it. This invention also may be applied to various other forms of ball and socket joints.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

FEEDING DEVICE—1,746,242. In this invention a slicing machine including a knife and an article supporting plate is equipped with a feeding means comprising a main shaft for moving the plate in equal predetermined increments transversely of the knife. A cam element is actuated by the main shaft, a rack member moves the plate, and means intermediate the cam element and rack member are adapted to actuate the rack member under the control of the cam element. Means also are provided to move the intermediate means into engaging position when the plate is out of slicing position and into disengaging position when the plate is in slicing position. This patent has been assigned to Dayton Scale Co., Dayton, O.

UNIVERSAL JOINT—1,746,325. Comprising this invention are bifurcated shaft members having bearing supports in the furcations, a trunnion member having an annular portion provided with an annular chamber, opening laterally of the trunnion member, and a closing for the chamber which is composed of a cap pressed into the mouth of the chamber to seal it. Trunnions extending radially outward from the annular member and central channels communicate with the annular chamber. Assigned to Reo Motor Car Co., Lansing, Mich.

VALVE—1,746,367, for a valve with a discharge controlling means including in combination a flexible imperforate member and a rigid part. The flexible member is held against the rigid part and means are employed for introducing fluid between them. The flexible member is mounted to yield outwardly under the influence of fluid pressure from within the valve to permit discharge past its edge to the exterior. Assigned to Super-Diesel Tractor Corp., LaPorte, Ind.

AUTOMATIC CLUTCH—1,746,805. The combination of a fly wheel and a unitary clutch, a driving shaft connected to the fly wheel, and driven shaft comprise this invention. The clutch comprises two sets of plates, one set being arranged to rotate with the fly wheel, and the other set of plates arranged to rotate with the driven shaft. Automatic and manually controlled means respectively actuate the clutch. Assigned to Automatic Drive and Transmission Co., Gloucester City, N. J.

BALL BEARING SHEAVE—1,747,745 pertains to "the combination of a sheave pin, a plurality of sheaves mounted thereon with adjacent hub cavities forming a continuous chamber, ball bearings for the sheaves in said chamber, sealing means between sheaves and between sheaves and pin, and means for forcing lubricant into said chamber." Assigned to Blaw-Knox Co., Pittsburgh, Pa.

COMPOSITE GEAR—1,745,571 for "a laminated gear blank composed of woven fabric treated with phenolic condensation product, said blank comprising a stack of disks extending from the hub of the gear to the periphery so as to form the web and a part of the rim." The rim has additional rings or segmental elements superimposed on each face of the peripheral portions of the disk to increase its thickness. Web and rim portions are of substantially equal density. Assigned to Fibroc Insulation Co., Valparaiso, Ind.

AIRPLANE BRAKE—1,746,017 for an airplane brake device comprising a shaft, a wheel including a tire and rim rotably mounted on said shaft, a brake drum supported by the rim within the lines of the tire, a brake supporting member journaled on the shaft. Brake members are independently mounted on said brake supporting member on either side of the shaft, in position to coact with the brake drum. Hydraulically actuated operating members are similarly mounted and independently connected to the brake members to actuate them. Assigned to Ford Motor Co., Detroit.

STRIP-FEEDING MACHINE—1,735,288. "In a machine for feeding a strip of stock, a frame, a guide carried thereby, a carriage slidably mounted on the frame, a feed-device comprising a sliding feed-box to move the stock toward the guide, means in the anchor-box to hold the stock in its forward position, and spring stressed cover-plates on said boxes having means to adjust the stock-moving and stock-holding means, respectively." This patent has been assigned to Interstate Iron & Steel Co., Chicago.

POWER TRANSMISSION GEARING—1,738,695, for an apparatus composed of a drive shaft and a driven shaft, pinions mounted on the shafts, a plurality of transmission gears meshing with each of the pinions at equi-

distantly spaced points and means for enabling the transmission gears to alter their positions about the axis of one of the shafts. Assigned to Robert L. Dennison, Kansas City, Mo.

BALL PLUNGER SUPPORT—1,748,086, comprises "the combination with a plunger, of a ball socket provided with a spindle threaded into said plunger, a lock nut for holding the spindle in adjusted position, a ball in said socket, a spring interposed between said socket and ball and a cap nut threaded on said socket for holding the ball in position." Assigned to Chesley T. Small, St. Louis.

SPINDLE BEARING—1,748,174, "In a bearing for a spindle or shaft, the combination with a supporting hub and said spindle of a set of ball bearings arranged around the spindle and bearing on it, an eccentric support for each ball bearing and means for simultaneously adjusting the supports of said ball bearings from a single one of them to take up wear all around the spindle equally." Assigned to Leland-Gifford Co., Worcester, Mass.

SHAFT MOUNTING—1,748,156, comprising "a shaft, a support therefor, a journal box connected to said support, roller bearings between the shaft and journal box, a flanged disk closing an end of the journal box, a cup-shaped disk spaced from the first disk, packing interposed, between said disks, a stop on said shaft and a coil spring interposed between the stop and cup-shaped disk." Assigned to American Car & Foundry Motors Co., New York.

FRICTION CLUTCH—1,748,148, in this invention release levers pivoted on the outer ends of studs are arranged to have rocking motion communicated thereto to retract the pressure plate against the action of its springs. A plurality of adjustable means provide a fulcrum for each of said levers, each means comprising a separable adjustable cam plate at each of said studs mounted on the back plate beneath the release lever associated with the stud. Assigned to Borg-Warner Corp., Chicago.

BEARING STRUCTURE—1,748,120, comprising in combination, a bearing structure including separable sections, bushing sections in the respective bearing sections and each provided in its bearing face with a groove terminating short of the edges thereof, each bushing section also having in its outer face a circumferential channel extending from edge to edge thereof and provided with holes opening into said groove. Shims between the bearing sections form fluid-tight closures and oil is supplied under pressure. Assigned to Waukesha Motor Co., Waukesha, Wis.

HYDRAULIC RELAY GOVERNOR—1,748,326, "In a governor for a machine, the combination with a driving element of the machine and a device controlling the operation of the machine, of fluid controlled means to actuate said device, means providing a working fluid inlet and outlet and two passages for flow of working fluid toward and from said fluid controlled means, pilot valve mechanism comprising a valve and free floating sleeve movable relatively one to the other and adapted to be positioned to connect said fluid inlet with either of said passages and said fluid outlet with the other of said passages. Assigned to DeLaval Steam Turbine Co., Trenton, N. J.

Professional Viewpoints

(*Concluded from Page* 47)

not get along without scientifically trained ingenieurs to do the work in research, testing and experimental laboratories. Schools raised their level, a great many new schools appeared and the World war did the rest. So great was the cry for technical men that the American youth flocked to the technical schools and today we have an unbelievable number of high grade technical colleges. And in the last five years another change took place, very slowly: The demand for "draftsmen" in the technical magazine and newspaper advertisements diminishes, and instead there appear "ads" for mechanical engineers to design machines, or to increase production, and even to fill the position of superintendent!

However, to come back to the original question, "draftsman or ingenieur," which should it be? There is still a great majority of manufacturers and superintendents to whom a draftsman means nothing more than a man who can draw up machine parts after they have been built in the shop. So there is still much work ahead for the professional "draftsman" to convince the practical men that they are ingenieurs and not tracers.

But are they? Not as long as the custom prevails for an engineering department to employ graduates from high school to learn drafting. Some boys will learn "drafting" and some will go to technical colleges in the evening and become ingenieurs, but who pays for that? Any chief draftsman will agree with me if I say that it takes a lot of his or the older designer's time to teach the boys, time which could be spent more profitably for the firm.

Much could be accomplished if the great national technical societies would take this up and prevail upon their men in executive positions to give those in the offices the status of ingenieur instead of draftsman.

—"AN OLD DRAFTSMAN"

Sound-pictures have made their advent in sales work. Portable photophone projectors are to be installed in each of the ten district offices of the General Electric Co., Schenectady, N. Y. Through the medium of the photophone, salesmen and customers will see the latest developments in apparatus and hear descriptions of the processes of development and methods of application.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

THE deanship of the college of engineering of New York university has been accepted by Collins P. Bliss, formerly associate dean. Announcement of this appointment was made by Charles H. Snow, the retiring dean, at the annual dinner of the arts and engineering alumni of the university, Feb. 12. Professor Bliss played a major part in initiating the aeronautical course at New York university. In recognition of his work while in charge of the Popular Science institute he was appointed consulting engineer to the bureau of standards, Washington. In 1888 he was graduated from Princeton university and from the Columbia School of Architecture in 1891. He has been a member of the American Society of Mechanical Engineers since 1903.

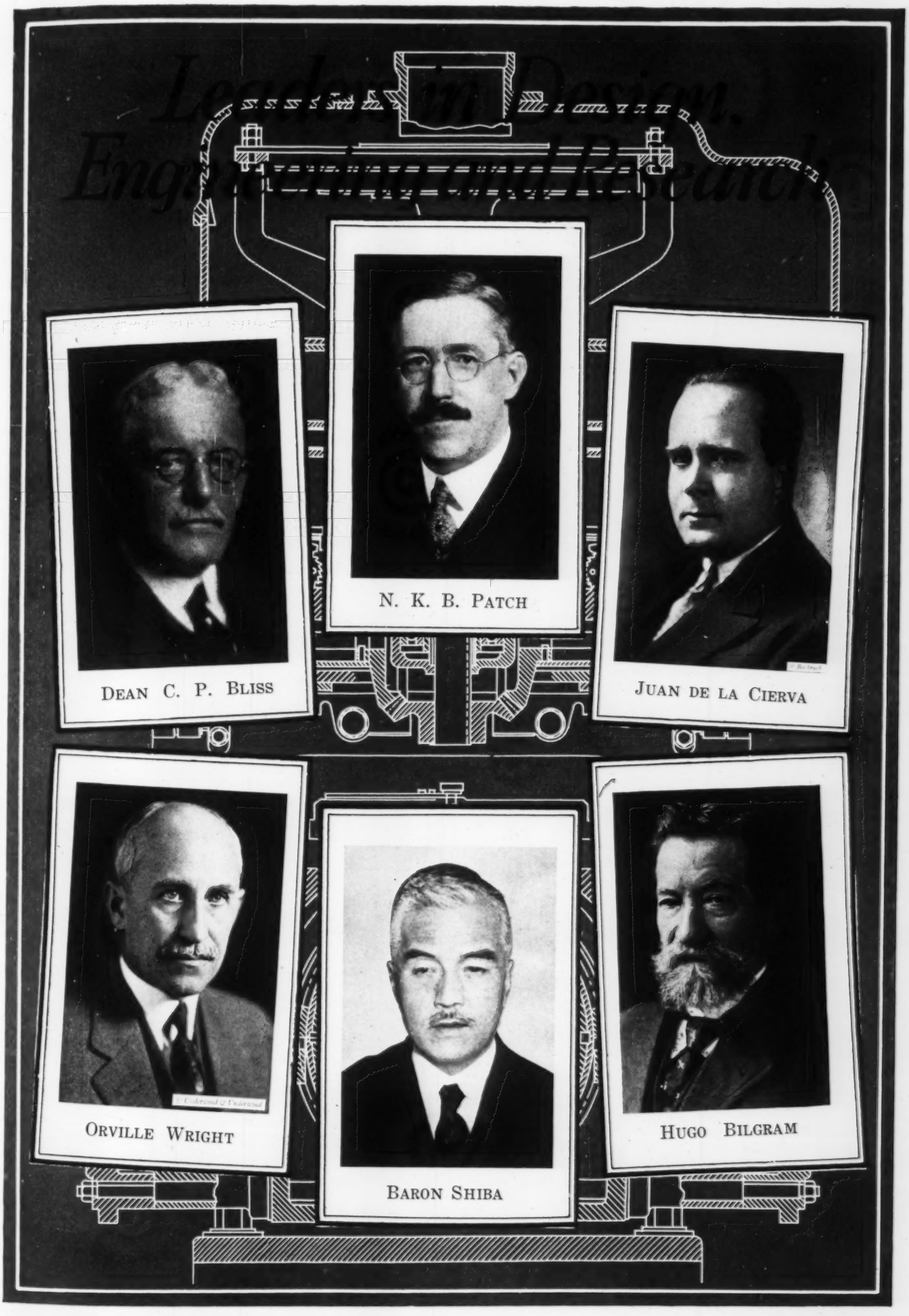
AT a recent meeting of the nominating committee of the American Foundrymen's association at Cleveland, Nathaniel K. B. Patch was nominated for president. Mr. Patch is secretary of the Lumen Bearing Co., Buffalo, N. Y., and has been active in the Foundrymen's association for many years. Born Feb. 15, 1879 in Houghton county, Michigan, he received his early education in the public schools of Hancock and Hubbell, Mich. In 1897 he entered Massachusetts Institute of Technology but was forced to abandon his studies in 1900 because of poor eyesight. Jan. 1, 1901 he entered the employ of the Lumen Bearing Co., becoming manager of the Canadian branch at Toronto, Ont., in July 1904. In April 1912 he returned to the Buffalo plant to act as secretary of the company and plant engineer. He was appointed secretary of the company in 1919.

PRESENT emphasis on safety factors in the design and construction of airplanes brings to mind the efforts of Juan de la Cierva, the inventor of the autogiro. He returned to Europe late last year after having spent some time in this country in consultation with Harold F. Pitcairn of Picairn Aviation Inc., which company is licensed to manufacture the autogiro in this country. Senor Cierva was born in Murcia, Spain, in 1895 and obtained a degree in civil engineering at Murcia university. His interest in the autogiro developed in 1918 when a large three-engined airplane he had constructed was destroyed after stalling. Senor Cierva is a member of a number of scientific organizations in Spain and France.

IN RECOGNITION of his achievement in the design and construction, with his brother Wilbur, now deceased, of the first successful engined-propelled airplane, Orville Wright has been named the first recipient of the Daniel Guggenheim Medal for Aeronautics. The announcement was made recently by the board of award which is directing a fund set aside in 1927. According to the provisions of the fund a medal will not be granted oftener than annually for" notable achievement in the advancement of aeronautics." The medal will be presented to Mr. Wright at Washington, April 8, at the time of the fiftieth anniversary celebration of the American Society of Mechanical Engineers.

PRESENTATION of the Holley medal to Baron Chisaburo Shiba for his accomplishments in developing the highest known rapidity in the photographing of scientific pictures, was one of the highlights of the recent World Engineering congress at Tokyo. His apparatus is capable of recording pictures at the rate of more than 20,000 frames a second. The medal was presented to Baron Shiba at a dinner held in his honor by the American Society of Mechanical Engineers, and is named for Alexander Lyman Holley, a famous metallurgist. It was founded by George E. Rockwood of Worcester, Mass.

DISTINGUISHED as a designer and pioneer manufacturer of gear cutting machinery, Hugo Bilgram, president of the Bilgram Machine Works Inc., Philadelphia, recently celebrated his eighty-third birthday. His technical education was obtained in Bavaria where he was born Jan. 13, 1847 and in 1869 he emigrated to this country. Philadelphia was his destination and it was there he later became head of his own organization. In 1875 while employed in the Southwark foundry as a machine designer he found that by


N. K. B. PATCH
DEAN C. P. BLISS
JUAN DE LA CIERVA
ORVILLE WRIGHT
BARON SHIBA
HUGO BILGRAM

a modification of the Zeuner slide valve diagram the solution of some problems was facilitated and he elaborated its application to reversible and variable expansion gears. Mr. Bilgram built his first bevel gear generating machine in 1883. Later he devoted his engineering skill to the designing and building of cigarette machinery.

* * *

William Schroeder has been appointed chief engineer of the Mercury Mfg. Co., Chicago. He comes to the Mercury company from the Western Electric Co., Kearney Works, where he was department chief for the past two and one-half years in the factory planning and materials handling division. During the World war he served as assistant chief draftsman in the engineering division of the Motor Transport Corps at Washington, sharing responsibility in designing the late class B army truck.

* * *

E. D. Johnston recently retired as president of P. H. & F. M. Roots Co., Connersville, Ind., when that company was merged with other blower manufacturers into the Stacey Engineering Co., Columbus, O. He continues, however, as one of the directors. He has been identified with the Roots company for the past 45 years and designed the first high pressure blower and gas exhauster of the positive displacement type.

* * *

John T. Wilkin, president and chief engineer of the Connersville Blower Co. Inc., Connersville, Ind., was chosen general manager at a recent meeting of the board of directors. E. C. Hassler, assistant superintendent, was made acting superintendent.

* * *

James C. Barnaby has been appointed consulting engineer of the Buffalo works, Worthington Pump & Machinery Corp., Harrison, N. J. He has been in New York office as engineer since 1922.

* * *

Frederick A. Melmoth, formerly in charge of the foundry of Thomas Firth & Sons, Sheffield, England, and internationally recognized as one of the leaders in the steel casting production field, has been appointed technical director of the Detroit Steel Casting Co., Detroit. He will have charge of production methods and will also direct the development of special alloy steels.

* * *

Charles M. Moss, assistant manager of the circuit breaker engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been appointed manager of the engineering department at the company's South Bend, Ind., works. He has been with the Westinghouse company since 1902.

* * *

S. B. Taylor recently was appointed assistant works manager of the Reliance Electric & Engineering Co., Cleveland. He entered the employ of the company in 1925 as designing engineer of alternating current motors and in 1928 was advanced to engineer in charge of drafting, which position he held until the time of his recent advancement.

* * *

George H. Palm, for the past six years engineer with the new development division of the Yellow Coach & Mfg. Co., Pontiac, Mich., a division of the General Motors Corp., has become connected with the Young Radiator Co., Racine, Wis., manufacturer of truck, bus, power unit and engine cooling radiators. He will be engineer in charge of radiator construction and equipment.

* * *

B. S. Harris, chief engineer in charge of the experimental department of the Massey-Harris Co., Toronto, Ont., recently was made a member of the board of directors of that company.

* * *

Edwin Gamble, formerly chief engineer, has been appointed general manager of the Borg & Beck Co., Chicago.

* * *

Commander E. E. Wilson has been appointed vice president and general manager of the Hamilton Standard Propeller Corp., with main offices at Pittsburgh, Pa. He formerly was chief of the engine and design section of the bureau of aeronautics.

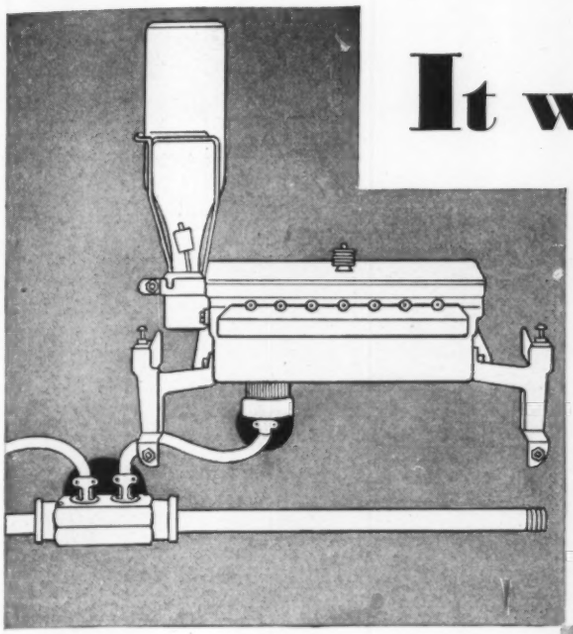
* * *

Charles Healy Day was recently appointed vice president of the New Standard Aircraft Corp., Paterson, N. J. He was formerly vice president and chief engineer of the Gates-Day Aircraft Corp., of that city.

* * *

H. E. Foote has been appointed to the incumbency of the Mellon Institute of Industrial Research's industrial fellowship on oxygen. This fellowship has been established by the Gas In-

(*Concluded on Page* 70)



It was simple to add

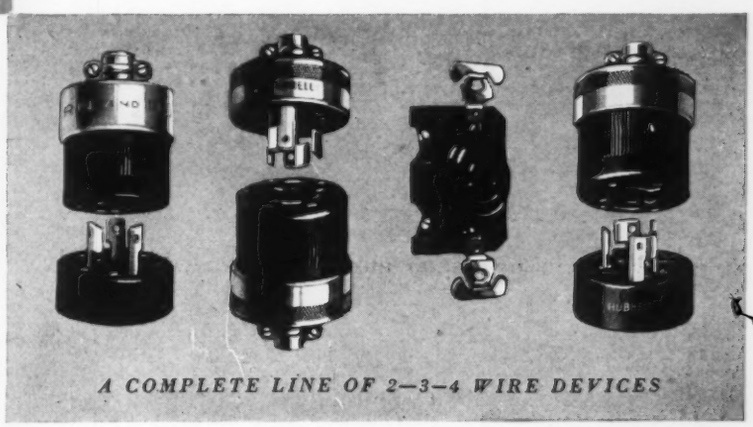
3 excellent features to this machine...

Disassembly convenience
Uninterrupted operation
and Safety . . . . provided
by Twist-Lock Devices

SIMPLY by incorporating Twist-Lock connections, makers of electrically operated and motor driven machines add features of real advantage to their equipment . . . Important features that customers appreciate.

On many machines disassembly convenience has been gained by using Twist-Locks in place of direct electrical connections. No need to tear down these machines when a motor or part must be removed for repairs. The Twist-Lock Device can be easily separated when necessary, although it cannot part accidentally.

To insure uninterrupted operation of portable and semi-portable machines, Twist-Locks are being extensively used instead of standard separable connections. Time-wasting disconnection trouble is positively eliminated by Twist-Lock Devices.



A COMPLETE LINE OF 2—3—4 WIRE DEVICES

They *stay connected* under severe vibration, pull and rough usage.

These devices protect the operator of a machine against electrical hazard, too. Proper grounding supplied by a 3 or 4-wire Twist-Lock Device avoids possible danger.

Take advantage of Twist-Lock features—make them features of your machines. Use the coupon to obtain full details about these devices.

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(M.D. 3-30)

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

THE Second International Aeronautical exposition held recently at the Arena in St. Louis was characterized by refinements in the design of new models rather than structural changes. The fact that manufacturers are making every attempt to improve the appearance of their products was outstanding. Absence of sensational departures in design was mitigated by the presence of numerous interesting details.

Probably the most prominent departure from standard aerodynamic practice was the floating aileron embodied in the design of the Curtis Tanager which recently was awarded the $100,000 prize in a safe aircraft contest sponsored by the Daniel Guggenheim fund. It was the only plane having both wing flaps and slots, while the Whittlesly Avian had slots alone. The show indicated the progress of metal construction but wood remains the favored material for wing construction with fabric for covering.

* * *

Fiftieth Anniversary Is Celebrated

Members of the Cleveland Engineering society celebrated the fiftieth anniversary of the organization at Cleveland, March 14 and 15. The ceremonies were held at Hotel Hollenden and engineers from Ohio and neighboring states were present. Inspection trips to plants and engineering projects in Cleveland and vicinity comprised a part of the program, concluding with a banquet.

* * *

New Airplane Engine Is Developed

Exclusive rights to manufacture an aviation engine of revolutionary character, according to Alfred Swartz, consulting engineer, Holloyt Motor Corp., New York, inventor of the unit, have been issued to Wright Aeronautical Corp., Patterson, N. J. Mr. Swartz is an eminent metallurgist and gas chemist, and is president of the Wing Aeronautical Corp., New York.

The new engine produces a horsepower unit with considerably less fuel than other engines in use today, it is claimed. Since this feature increases the pay load by a large percentage the engine fills an important need in air transportation. Complete combustion and conversion of heat into power that usually is lost, provide the added efficiency in the new engine. While the weight of the engine is lighter per horsepower developed than usual, the more noteworthy advantage is the reduction in fuel weight.

Construction of several experimental engines has been completed and further development of engine designs is under way at the Wright factory. Charles Lawrence, president of the company, has followed these experiments for nearly a year.

* * *

Offers $10,000 Prize for Scientific Work

Constituting the largest single award in America for scientific accomplishment, *Popular Science Monthly,* beginning this autumn, will confer an annual prize of $10,000 and a gold medal upon the American citizen who during the preceding year has been responsible for the achievement in science having greatest potential value to the world.

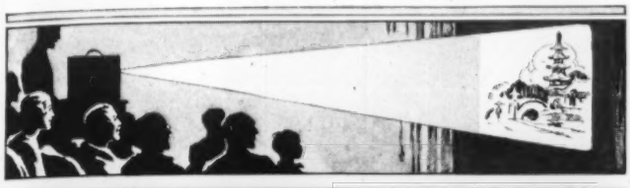
It is explained that the award is intended to heighten the interest of the American people in those conquests of the laboratory and the workshop which benefit the entire community and to focus attention upon the many scientific workers who, without thought of personal profit, toil to better man's control over his physical surroundings. Twenty-four leaders in American science have agreed to serve as a committee of award to administer the fund.

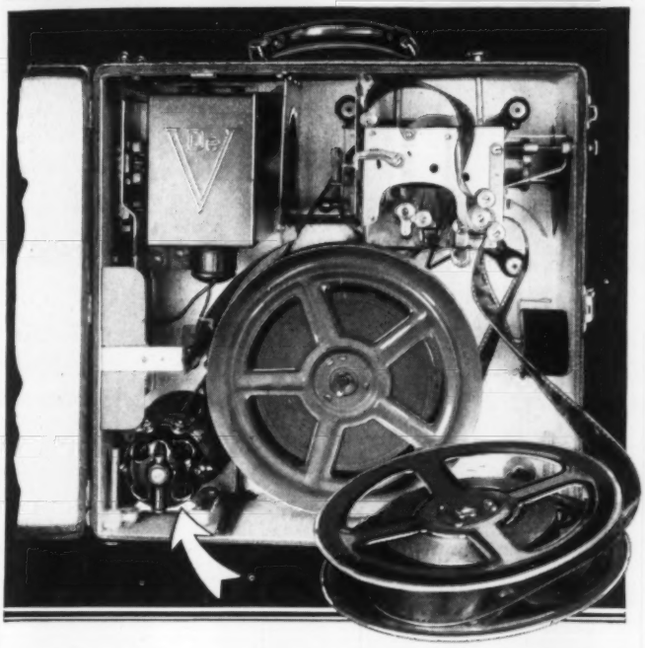
* * *

International Standards Work Progressing

A technical conference under the auspices of the International Standards association, of which the American Standards association is a member, will be held in Paris in May. Seventeen foreign countries have standardizing bodies represented in the International Standards association and since the international conference on standardization in New York in 1926 these groups have established international co-operation on a num-

▲ ▲ ▲ HOW BODINE MOTORS SERVE DeVRY PORTABLE MOVIE PROJECTORS





IN the land of eternal ice, MacMillan amazed his Eskimo friends with DeVry motion pictures of America. Explorers in the humid jungles of Africa have astounded bewildered natives with motion pictures of other lands. In the channels of commerce, in the airplane, in the club car, or on the sea, DeVry Projectors daily animate the silver screen.

Bodine Motors, in several models, have served DeVry Projectors for many years under extremes of temperature and moisture that would quickly reveal constructional defects. *"The steady operation of the DeVry Projector,"* says a DeVry bulletin, *"is in a great measure due to the motor. Small as it is, this motor is so strongly constructed that failure is a rare occurrence, and, if oiled, will run for years without any trouble."*

Such ruggedness is traditional with Bodine Motors. They are built up to a standard of uniform, high quality. For this reason you will find Bodine Motors wherever unfailing performance is expected.

WHAT IS YOUR MOTOR PROBLEM?

ARE you seeking a motor that is engineered for your product? Do you want a motor with maximum power in minimum space? Are you anxious to improve the performance of your motor-driven appliances? If so, let Bodine Engineers test your unit and engineer a motor to exactly meet your requirements.

The Bodine Line includes direct current, alternating current and universal motors; also converters, motor generators, dynamotors, low speed units and frequency changers, from 1/4 H. P. to 1/1300 H. P. and for almost any speed. Send for the Bodine Catalog.

This is one of the Bodine Motors used on DeVry Projectors

The Motorgram is a bimonthly message mailed free to manufacturers interested in small motors. Let us put your name on the Bodine mailing list.

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ber of technical projects. This has been accomplished through the work of various technical committees.

Included in the 24 standardization projects now being worked out are: Screw threads; ball and roller bearings; pipe and pipe fittings; rivets; ships' elements; center heights of machine shafts; couplings between driving and driven machines; shafting keys; iron and steel classification; and standard diameters.

Seven of these 24 subjects will come up for detailed discussion at the forthcoming Paris meeting.

* * *

Hard Rubber-Like Substance Discovered

According to the United States bureau of standards a new substance somewhat like hard rubber in appearance and properties has been produced by hydrating cornstalks completely, drying the resultant jelly-like mass, and machining the finished piece to shape. The new material is called "Maizolith."

* * *

Standards Discussed By Testing Group

New test programs, the development of new standards and the revision of existing standards were considered at a recent meeting of committee A-1, on steel, of the American Society of Testing Materials, in Philadelphia. A number of subcommittees held meetings in conjunction with committee A-1 and contributed to the development of the new projects.

Changes in the standards methods of chemical analysis of plain carbon steels are being considered. The carbon, manganese, silicon, and possibly sulphur and copper determinations may be modified on certain types of steel. New methods for the determination of aluminum and alumina are to be developed.

Agreement has been reached with the Society of Automotive Engineers for increasing sulphur limits of bessemer screw stock from the present range of 0.075 to 0.15 per cent to 0.10 to 0.18 per cent in the standard specifications for commercial cold-finished bar steels and cold-finished shafting in order to improve the machinability.

* * *

Newly Designed Diesel Installed on Ship

A two-stroke cycle, double acting diesel engine capable of developing 7000 brake horsepower at 95 revolutions per minute, the first of its kind, has been installed in the ocean-going motorship, the AMERIKA built by the East Asiastic Co. Trials held recently in the sound near Copenhagen showed easy starting, ahead and astern, the engine running quietly up to full speed without vibration.

An average speed of 15.55 knots was obtained, the corresponding power of the engine being 7670 brake horsepower or 8613 indicated horsepower at 111 revolutions per minute. A test of six hours' duration with the main engine developing 6450 brake horsepower gave a consumption of .37 pound of fuel per brake horsepower per hour for all purposes. From previous experience it is expected that the efficiency of the engine fully run in during actual service will increase about four per cent. Burmeister & Wain built the newly designed engine.

* * *

Standardization Reports Up For Approval

Standardization of transmission roller chains, sprockets and cutters has been under consideration of a sectional committee sponsored by the American Society of Mechanical Engineers, the Society of Automotive Engineers and the American Gear Manufacturers association for the past few years. The committee's task was to review the standards then existing and to formulate a proposal for adoption as an American standard that would be applicable to uses other than automotive drives.

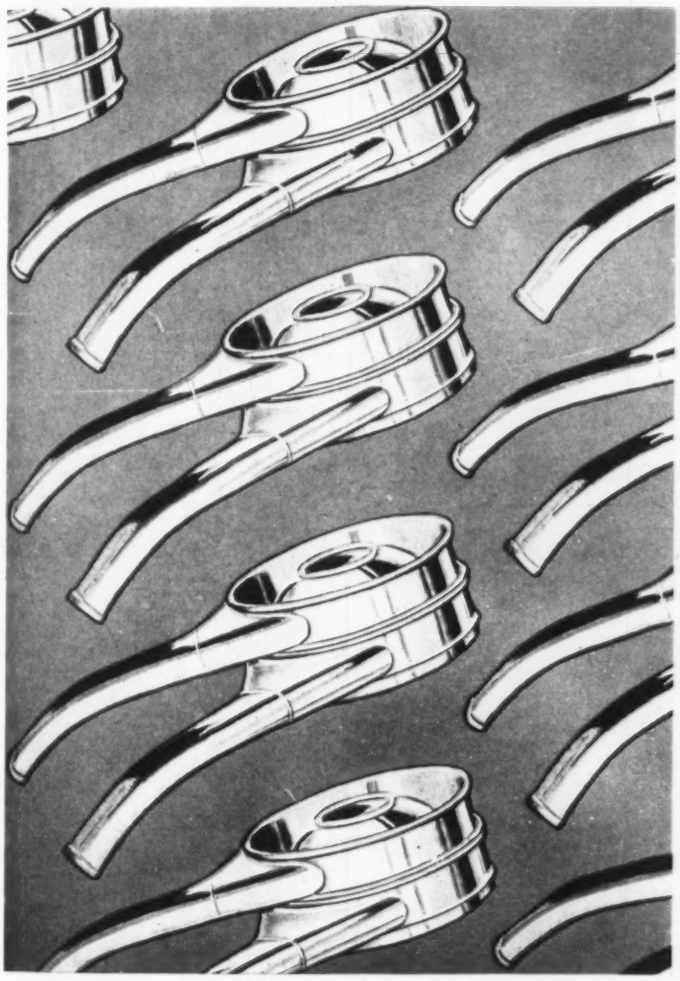
The division of the project dealing with roller chains was assigned to subcommittee No. 1, G. M. Bartlett, chairman, which has completed its proposal. The report has been approved by the sectional committee. It is now before the three sponsors for approval and transmission to the American Standards association. To secure as far as possible international uniformity in roller chain standardization, contacts were maintained with roller chain interests abroad. Copies of the complete report are available to those interested in reviewing it.

* * *

Funds For Alloy Research Subscribed

Funds have been subscribed for a five-year program for alloys of iron research, it has been announced by Alfred D. Flinn, director of Engineering Foundation. Personnel is now being engaged for the research which is to be primarily a collection and critical review of literature on iron and its metallic alloys. A minimum of $30,000 a year will be required to carry out the work, it is estimated. The research work will be in charge of Frank T. Sisco, formerly chief of the metallurgical laboratory, Wright field, Dayton, O. He has established offices in the Engineering Societies building, New York.

THESE SHORT-CUT PRODUCTION Methods Mean Worth While Economies



The separator manufacturer for whom these parts were made found that G. P. & F. could supply better stamped parts at less cost than he could make them in his own plant.

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Please send your 1930 Booklet, "In Harmony with Modern Progress," to the address below. It is understood the writer is not obligated.

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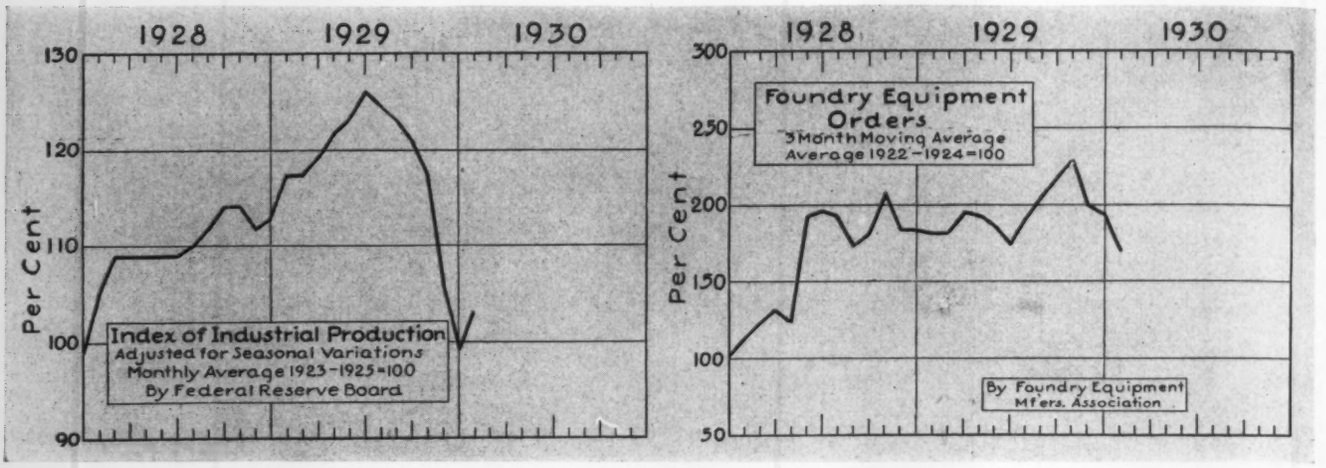
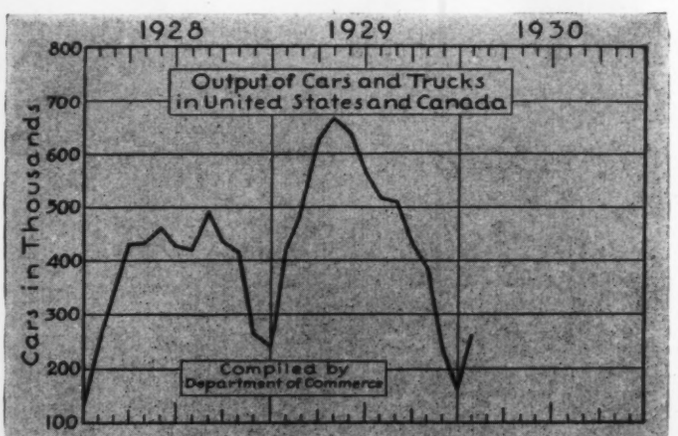


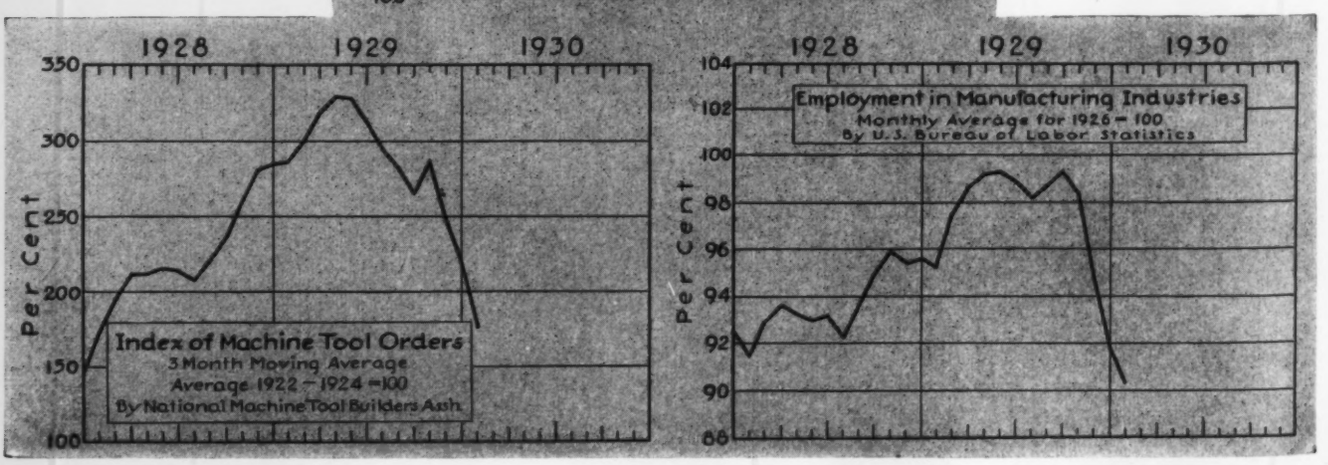
How Is Business?

BROADLY the general swing of business is upward with confidence strong in the long-term outlook. The immediate future continues hedged with uncertainties, however, and some disappointments. In the machinery industries improvement is gradual with the general level of activities considerably below that of a year ago, as indicated by the accompanying charts.

Reviving interest is reflected in some centers by inquiries for designers and draftsmen. In January, however, new orders for machine tools again declined, dropping to the lowest level for any month in two years. The three months moving index was 175.4 for January compared with 221 for December, 285.6 for January, 1929, and 173.6 for January two years ago. Little improvement is expected before summer. Steel-making operations are slightly less vigorous as March opens, a month which normally sees the spring upturn in the steel industry in full stride.

Some expansion in automotive and building construction seems certain this month but it is evident that the pace will be less rapid than a year ago. While the general level of iron and steel prices continues to be downward, plates and shapes still hold at 1.80c, base, Pittsburgh, with cold drawn bars and shafting 2.10c, Pittsburgh. Copper products are in good demand and sales of brass products are moderate. Copper is selling at 18.00c, and yellow brass rods, 21.25c. Conditions favor hand-to-mouth buying.





SPOTS of HEAT
for Your Process Machinery

Yesterday—when a machinery builder wished to build heat into his machines, or an industrial executive wished to apply a limited amount of heat to a process—it was necessary to install a steam boiler, or to run complicated fuel pipe lines to the zones to be heated.

To-day, the manufacturer needs only to specify:

1. G-E Cartridge Units. Simple, compact cartridges which, when slipped into the zone to be heated, supply clean, safe, concentrated heat at the throw of a switch.
2. G-E Immersion Units. Handy, self-contained units which can be screwed into tanks, kettles, or compartments for the heating of oil, water, wax, etc.
3. G-E Strip Heaters. Strips of heat which can be attached to process machines, pipe lines, warming tables, etc., to supply limited zones of heat; or which can be suspended from ceilings, or clamped to walls to heat isolated structures.
4. G-E Formed Sheath-wire Units. A type of electric heating unit in great demand because it can be custom-built to supply heat to special or "hard-to-heat" processes and machines.

Practically every manufacturer can use these modern, electric heating units somewhere in his manufacturing processes. Investigate! Without obligation, General Electric engineers will give you freely of their time concerning the application of these units in your plant.

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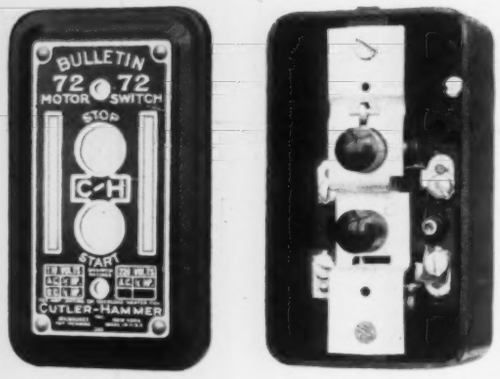
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged In the Design of Mechanisms or Machines

Introduces New Overload Switch

PROTECTION against motor burnouts and a preventative against blowout fuses due to overloads are some of the claims for the new free tripping thermal overload switch recently announced by Cutler-Hammer Inc., Milwaukee,



Free-tripping thermal overload switch with cover removed to show interior

Wis. The new unit is known as Bulletin 9101 and is being manufactured for fractional horsepower motors. A time limit type of thermal overload is furnished in numerous ratings up to and including ¾ horsepower, 110 volts, 220 volts alternating current, and ¼ horsepower 115 volts direct current. When an overload trips the switch, it is reset by simply pressing the starter button, which also restarts the motor. If the overload condition persists, the motor will not start. The new switch is intended for use with industrial and domestic appliances and tools, including such equipment as washing machines, refrigerators, grinders, polishers, oil burners, etc.

New Alloy Iron Resists Abrasion

POSSESSING a close uniform grain and toughness as well as abrasive and compression resistance, a new alloy iron known as Ironite recently was announced by the Kinite Corp., Milwaukee. According to the manufacturer the newly developed material has properties similar to Kinite, providing the same advantages but in a lesser degree and does not wear as long. It is cast to shape, thereby saving machining. Ironite is an electric furnace iron and among other alloys, chromium, vanadium and nickel play an important part in its composition. The new alloy is recommended for forming dies, machine parts or wherever a close textured, tough alloy iron is required.

Simplicity Is Feature of Bearing

SIMPLICITY of construction characterizes the Fafnir-Melcher railway roller journal bearing announced recently by Fafnir Bearings Inc., New Britain, Conn. A sleeve comprising the inner race, a roller assembly and an outer housing in which the roller path is integral, are the three main parts. The sleeve being shrunk or pressed on the axle furnishes a wear-resisting surface for the operation of the rollers. In the design of the box provision is made for alignment and flexibility.

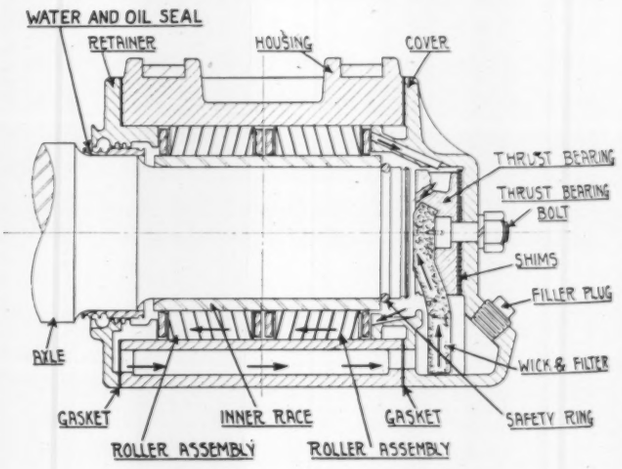


Diagram showing details of bearing and path of lubricant indicated by small arrows

Rollers need take only radial load as all lateral thrust is absorbed by bronze thrust bearings, for

Oilgear Feed *insures* fast operation for this giant drill

THIS great Thomas Drilling Machine with Indexing Table, developed and built by the Thomas Spacing Machine Co. of Pittsburgh, Pa., is used for the fast and accurate drilling of holes in structural steel fabricated shapes. It must be fast . . . must be accurate. Hence Oilgear Feed is an integral part of the design.

Oilgear Feed gives this drilling machine great flexibility for different drilling speeds and provides a rapid traverse. Its maximum feeding pressure is unusually high. Coupled with the high power delivered to the drill through the direct transmission, this results in extremely fast drilling through any sort of material.

Both builders and users of machine tools should learn about the splendid advantages of Oilgear Feed; how its smooth, cushioned, positive power can double machine production on an endless variety of work; how it prolongs the life of not only tools but the machine itself. Write for special Oilgear bulletins which give full details. The OILGEAR Company, 675 Park Street, Milwaukee, Wis.

For Your Protection

OILGEAR

Reg. U. S. Pat. Off.

This trade-mark appears on the name plate attached to the pump unit of every genuine Oilgear Feed

OILGEAR

THE PERFECT MACHINE FEED

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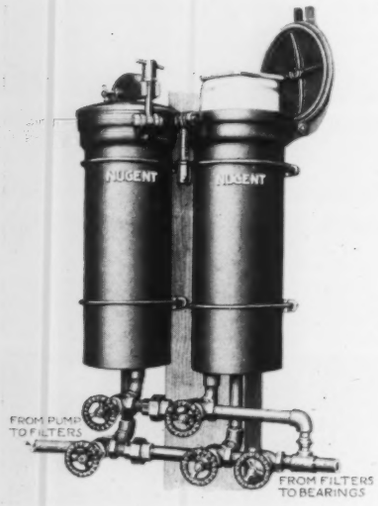
(A-1637)

which efficient lubrication is furnished. Essential features of the lubrication system are a wick which draws oil from the reservoir to the axle, from whence by centrifugal action it is carried to the roller path, through the rollers and back to the well. The accompanying diagram shows the bearing in detail, and the path of the lubricant, which is indicated by the small arrows.

Designs Automatic By-Pass Filter

DESIGN of a high pressure automatic by-pass filter for fuel and lubricating oils has been announced by William W. Nugent & Co., Chicago.



High-pressure automatic by-pass filter. The cover of one tank is lifted to show filtering element which is rolled up about a distributing spool

One of the unique features of this new device is the arrangement which rings a bell when the filter needs cleaning. Open ends of four filtering elements are securely fastened to four projecting oil nozzles on a central distributing spool, through which the oil is forced into bags. The filtering elements are rolled up about this distributing spool with a wire spacing mat between each. Use of this mat permits the oil to reach all of the surface, thereby obtaining a large amount of filtering area in a small space. Filtering elements are made of different grades and density of fabrics to filter oils of different viscosities successfully. These filters are used on diesel engines, electric locomotives, airplanes, tractors, printing presses, paper machinery, rolling mills, gear drives, large bearings, etc.

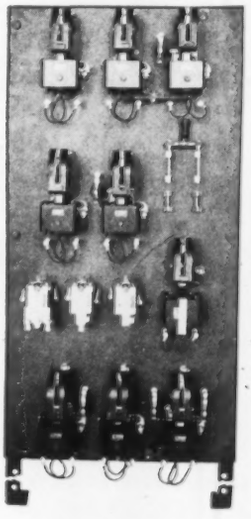
Bearings Designed for Airplanes

BALL bearings designed to fill the needs of airplane control systems have been announced by the Fafnir Bearing Co., New Britain, Conn. The new line of bearings has been developed to meet the demands for easier and more uniform operating controls, less attention to greasing, fewer repairs and replacements and elimination of jammed or "frozen" controls. In addition to ball bearings for stabilizer adjustment mechanisms, rudder and brake pedal bars, steering wheels and sprockets, stick mechanisms, bell cranks and other control devices, the new line includes ball bearing units for airplane wheels, designed for minimum friction with maximum loads on landing and tail wheels.

In the adaptation of the ball bearings to control systems, cartridges of self-contained seal construction, containing single or double rows of balls, are being made for exposed control points, the self-contained seals being said to eliminate the expense and trouble of designing and making special seals when ball bearings are used.

Control Panel Has Overload Relay

A REDESIGNED line of magnetic control panels for use with cranes has been announced by General Electric Co., Schenectady, N. Y. Two types of control are involved, one, designated CR-4426, is for use on the bridge and trolley motions of cranes, and the other, designated CR-4422, is for use on hoist motions. Each type of control is available in two forms, one with and one without overload protection. The circuit breaker contactor which opened only on overload, has been replaced by a line contactor. This is placed in the opposite side of the line to the reversing contactors and opens each time the master switch is returned to the "off" position, allowing complete isolation of the motor



Front view of magnetic control panel which incorporates new overload relays to allow a greater calibration range. A three-point cam-operated master switch is used

WITH

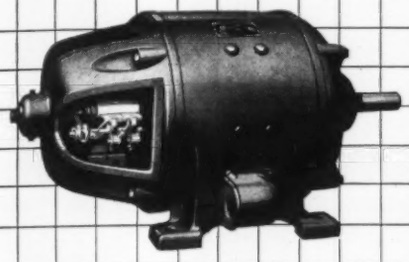
"Custom Built" Motors

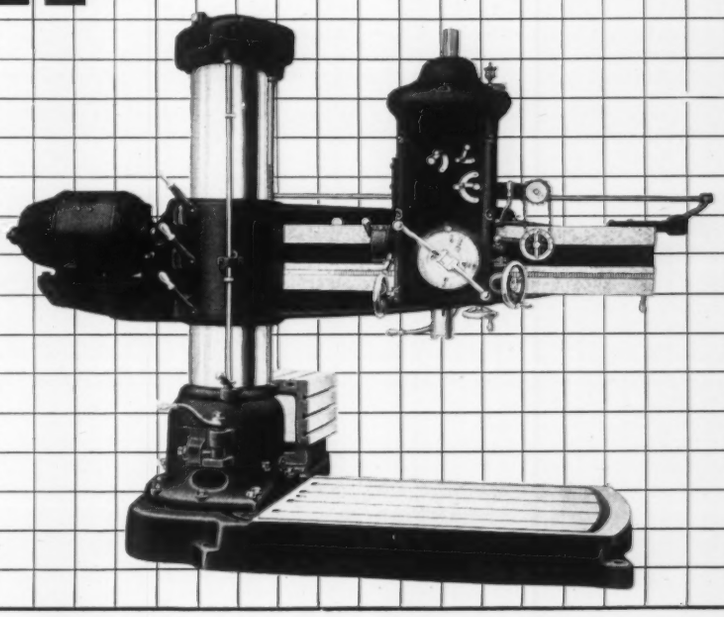
EFFICIENCY

MACHINE

UP

STEPPING





LOUIS ALLIS adjustable speed d. c. motor direct connected to radial drill of well-known make. The range of motor speed is 500/1500 r. p. m. With the usual control 21 motor speeds are available which, with 4 mechanical speed changes, make a total of 84 spindle speeds 23/1200 r. p. m.

"A Simpler and More Efficient Motor Application to Radial Drills"

... these are the words of the builder of the radial drill shown above.

And no wonder! The Adjustable Speed Motor *eliminates* the gear-box (usually located between the motor and column), which is ordinarily the principal factor in varying the spindle speed ... It reduces the overall length of the radial ... It saves power ordinarily wasted in the gear-box ... It increases the number of available speeds from the usual 24 or 32 to as high as 84 ... It permits adjustment to the most efficient drilling speed for each class of work ... It saves time for the operator by making possible complete speed control from the head.

This is just another example illustrating how Louis Allis "Custom-Built" motors ... selected or designed to suit the application ... are STEPPING UP MACHINE EFFICIENCY.

If you are striving to make machines that you build simpler, more efficient, and more saleable, it will pay you to consider L.A. "Custom-Built" motors. Louis Allis engineers will gladly co-operate with you in selecting or designing motors exactly suited to your needs. Their service is yours for the asking.

Write for bulletins describing L.A. "Custom-Built" Motors

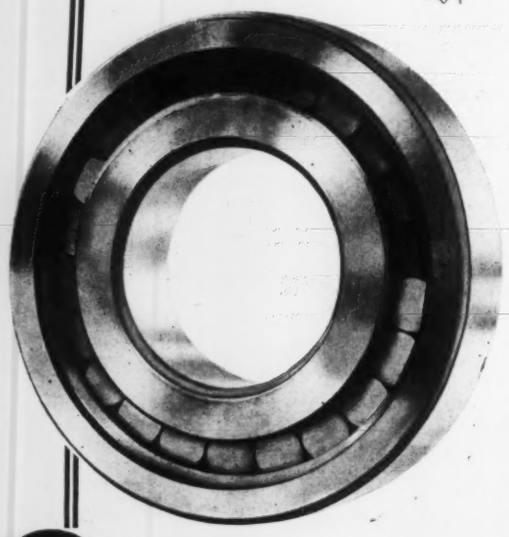
LOUIS ALLIS

"CUSTOM-BUILT" *Electric* MOTORS

THE LOUIS ALLIS COMPANY

MILWAUKEE, WIS.

Motor Specialists for 28 Years — *Offices in Principal Cities*



QUALITY

IN an anti-friction bearing sums up into its inherent ability to do more, last longer and serve better.

Not only in the manufacture of Rollway bearings, but also in their installation, our organization has kept this before them.

In this day of great organizations and immense mechanisms, the fact that designing engineers are coming to us in constantly increasing numbers with their newest problems, affords us considerable satisfaction together with an appreciation of the responsibility involved.

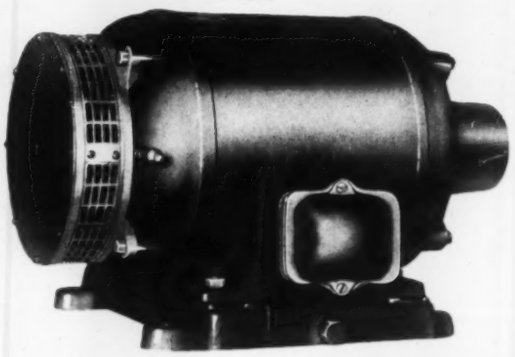
Our nineteen years' experience is at your service, if you have not already availed yourself of it doing so entails no obligation.

ROLLWAY BEARING COMPANY INCORPORATED
SYRACUSE NEW YORK
ROLLWAY CYLINDRICAL ROLLER BEARINGS

and starting resistor from the sources of power. A new type of three-point cam-operated master switch is used with the control. New overload relays also are incorporated, which allow a greater calibration range and permit the use of but one coil for a given contactor size.

Squirrel-Cage Motor is Fan-Cooled

TOTALLY enclosed fan-cooled squirrel-cage induction motors with ribbed cast iron coiled guards have been introduced by Century Electric Co., 1806 Pine street, St. Louis. As shown in the accompanying illustration, the fan and fan housing are mounted externally on the front end of the motor, opposite the pulley end. The cooling air is drawn in at the pulley end, circulated around and over the rear coil guard, through the air passages between the field core and the frame,



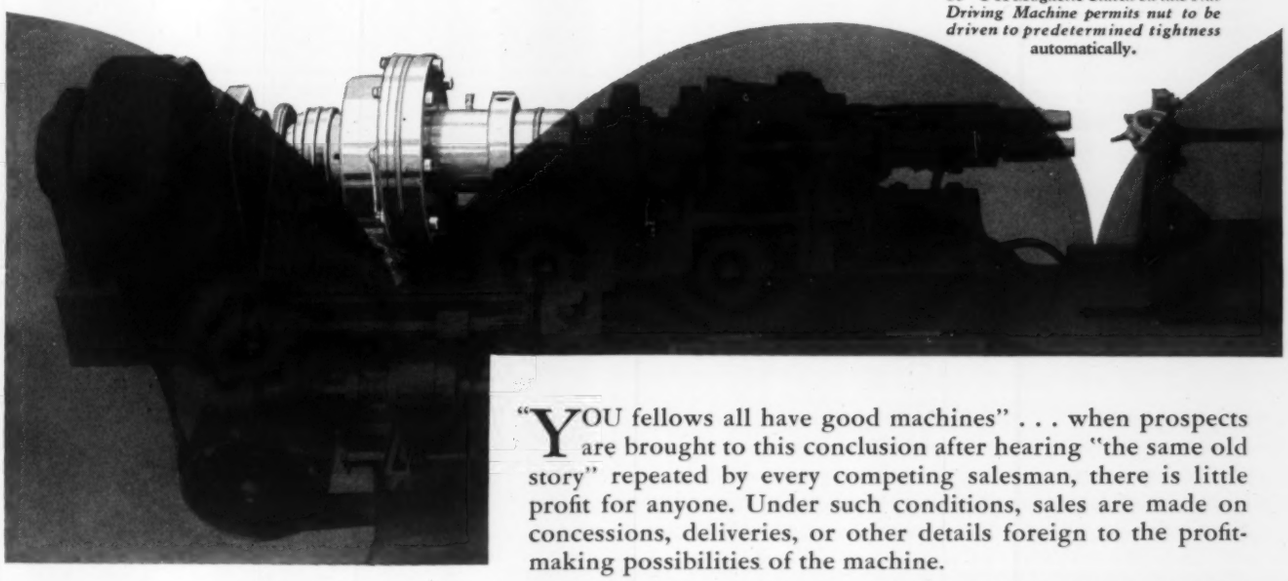
Totally enclosed fan-cooled squirrel-cage induction motor

out over the coil guard on the front end and discharged into the air through the fan and fan housing. Fan blades are radial.

Produces Unusual Reduction Units

AN INFINITELY variable speed reducer known as the "Revocentric" has been announced by the Universal Gear Corp., Chicago, and is being manufactured in sizes up to 15 horsepower. It is possible with this unit to have any output speed from 0 to 1/13 of the input speed and to vary the output speed over this range while the gear is in motion and under load. High-speed rotating parts are equipped with anti-friction bearings and the low-speed shaft is mounted in bronze bearings. In another speed reducer also produced by this company and known as the "Heliocentric," both the input and output shafts have two bearings within the reducer, eliminating the necessity of out-board bearings. The case is filled with oil or grease. Operating principles of the two units are described on page 20 of this issue.

How far should salesmen's problems dictate machine design?



10" C-H Magnetic Clutch on this Nut Driving Machine permits nut to be driven to predetermined tightness automatically.

"YOU fellows all have good machines" . . . when prospects are brought to this conclusion after hearing "the same old story" repeated by every competing salesman, there is little profit for anyone. Under such conditions, sales are made on concessions, deliveries, or other details foreign to the profit-making possibilities of the machine.

A machine may be the best constructed of its kind, yet lack a distinct advantage. Quality is taken for granted. Only quick-registering advantages can lift a machine out of the "just as good" class. To achieve these advantages usually means breaking with tradition.

One of many manufacturers who have found the answer to the problems of their salesmen by incorporating Cutler-Hammer Magnetic Clutches is the manufacturer of the Nut Driving Machine shown above. The C-H Clutch provides the simplest, most precise method of applying power and cutting it off. The clutch slips at a predetermined tightness and this slippage actuates a trip switch disengaging the clutch. Thus the C-H Magnetic Clutch is a safety device in addition to giving absolutely smooth load pick-up. It is the simplest clutch made—and the most adaptable. Any type of switch . . . limit, time, float, etc. . . . will actuate a C-H Clutch.

The booklet CL-1 describes C-H Magnetic Clutches fully and illustrates many other interesting clutch applications. A copy will be mailed at your request.

Built in sizes from 7" to 78"

C-H Magnetic Clutches Provide New, Effective Sales Advantages

C-H Magnetic Clutches consist simply of two parts . . . neither of which is subject to wear or friction. The armature member "dishes" to engage with the field member. Engagement at full speed is smooth, gradual, automatic; without jerk or jar; easy on motor and equipment. Since there is no end thrust and no heavy back-up parts, there is no strain on the shaft or on the driven member.

Engagement pressure is self-contained! C-H Magnetic Clutches are engaged and disengaged by means of push button or foot pedal located any distance away, or by means of limit, pressure, float switches and the like. Used on your machine they provide advantages which are appreciated by your salesmen and your customers alike.

CUTLER-HAMMER, Inc.

Pioneer Manufacturers of Electric Control Apparatus

1326 St. Paul Avenue MILWAUKEE, WISCONSIN

CUTLER HAMMER

C-H

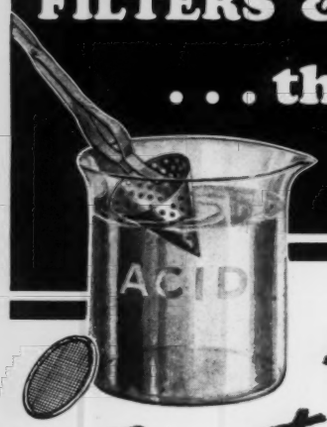
Magnetic Clutches Save Time and Save Equipment

A-333

for

FILTERS & SCREENS

. . . that won't corrode



use Fantalum!

IMAGINE a filter or screen, impervious to corrosion, which could be cleaned thoroughly and quickly by immersion in sulphuric acid—or even *aqua regia*, which could *stay* in such strong reagents indefinitely without being effected in any way!

Such screens, easily made at low cost from Fansteel Tantalum, would add a definite sales and performance point to many a product. And this is only one of the many important uses for Tantalum and the other Fansteel metals, now being made in ordinary commercial forms.

The Fansteel research laboratory has a large fund of useful, practical information on rare metals, and offers consultation service to manufacturers and designers without obligation.

This service, the metals themselves, and Fansteel Tungsten Contacts are described in an interesting way in our book, "Rare Metals"—which probably has suggestions of value to you. Send for a copy by means of coupon below.

look into this

FANSTEEL PRODUCTS COMPANY, Inc.
NORTH CHICAGO, ILLINOIS
Please send me a copy of "Rare Metals"

MR.....TITLE.....
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ADDRESS.....
CITY.....STATE.....
MD 3-30

(*Concluded from Page* 56)

dustries Co. Inc., Pittsburgh, designer and builder of liquid-air oxygen apparatus. The investigation is to be concerned with the extension of the present uses of oxygen. Dr. Foote has been a member of the institute's investigational staff since 1927.

* * *

B. B. Hood, formerly chief engineer of the American Chain Co., Bridgeport, Conn., has been appointed assistant to the general superintendent of the Procter & Gamble Mfg. Co., Port Ivory, Staten Island, N. Y.

* * *

John Hickey, who has joined the engineering staff of the National Pipe Bending Co., New Haven, Conn., will have charge of engineering in connection with research and new product development.

* * *

R. G. Wells has been made chief engineer of the Trundell Engineering Co., Cleveland, succeeding Mr. Eickhoff. Mr. Wells formerly was assistant chief engineer. Paul Van Sittert has been appointed to that post.

* * *

George H. Kublin has joined the engineering force of the Auburn Automobile Co., according to an announcement by the company.

* * *

Wallace F. Oliver has been promoted to chief engineer from assistant chief engineer by the Hydraulic Brake Co., Detroit.

* * *

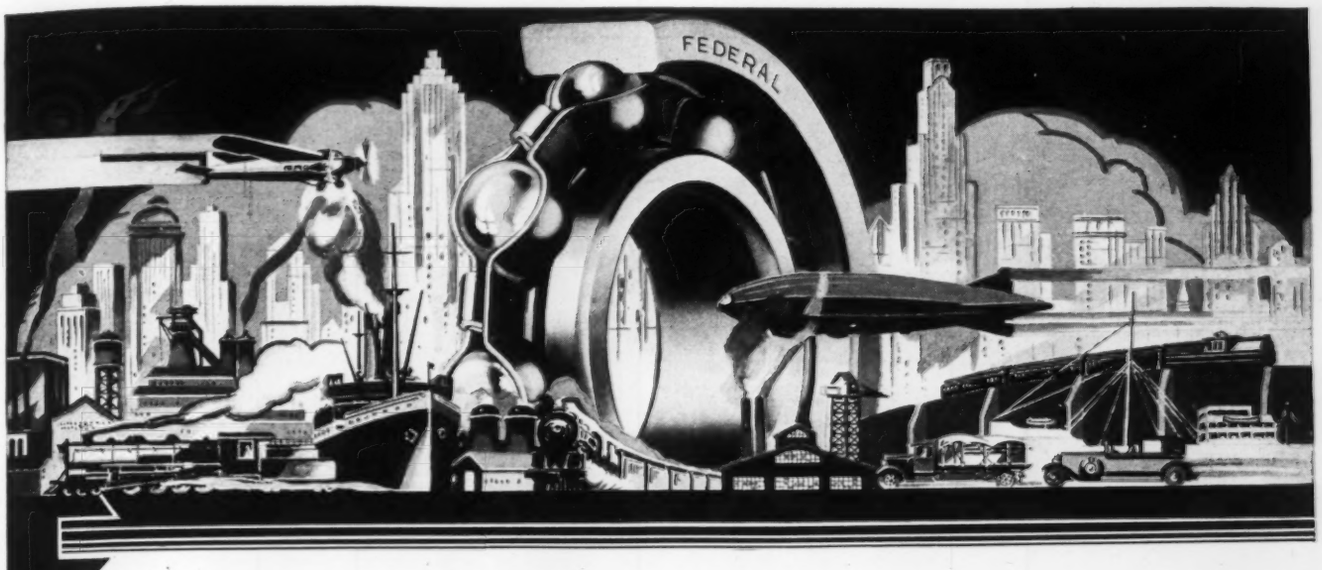
Neil E. Brooks, formerly assistant to the industrial engineer, is now chief draftsman in charge of industrial work for the Continental Motors Corp., Detroit.

* * *

L. F. Merrill has been appointed chief engineer for the Axelson Aircraft Engine Co., Los Angeles. He was connected with eastern aviation interests for eight years.

* * *

F. E. Harrell has been appointed engineer in charge of drafting and experimental departments of the Reliance Electric & Engineering Co., Cleveland. Mr. Harrell started with the Reliance organization in 1924 after graduating from Purdue university in electrical engineering.



ENGINEERS IN ALL INDUSTRIES DEPEND UPON FEDERALS FOR PERFORMANCE AND ECONOMY

Manufacturers who take pride in their product know the importance of *reliable* ball bearings. In all industries where bearing efficiency is desired, FEDERAL BEARINGS are chosen.

FEDERAL BEARINGS are notable for their quality. They are made of the finest high carbon chrome steels, and finished with exact precision. Each bearing is individually tested and inspected and backed by years of technical knowledge, skill and experience. That is why "FEDERALS" are used in preference to ordinary bearings.

THE FEDERAL BEARINGS COMPANY, Inc.
POUGHKEEPSIE, N. Y.

associated with

The Schatz Manufacturing Company, Poughkeepsie, N. Y.,
manufacturers of Commercial Annular Ball Bearings.

Detroit Sales Office: *917 Book Building*

FEDERAL
RADIAL BALL BEARINGS

ASSETS TO A BOOKCASE

Review of Books Pertaining to Design

Design Through the Ages

A History of Mechanical Inventions, by Abbot P. Usher; cloth, 401 pages, 6¼ x 9 inches; published by McGraw-Hill Book Co., Inc., New York, and supplied by MACHINE DESIGN for $5 plus 15 cents postage.

For those engaged in design who necessarily are deeply engrossed with everyday tasks, this book provides inspiration of distinctly valuable character. One is apt to overlook, in the present-day rush of affairs, the striking achievements and invaluable contributions to the mechanical sciences made by Archimedes, Hero, Leonardo da Vinci, Galileo, James Watt and others.

Professor Usher's book takes the reader through the development of technology and gives a systematic account of major mechanical inventions from the pre-Christian antiquity to modern times. No attempt is made to point out the economic consequences of the progress recorded, although the general chronology of the development has been given much attention.

Lesser known scientists and inventors are given due credit for the actual transformation of social life. "Carlyle made only one error . . . . he failed to recognize that the processes of history in their entirety involve not only the few who find themselves in strategically important positions, but also many obscure innovators.

That many years often elapse and seemingly may be wasted in the development of a machine, mechanism or process is indicated in the account of the development of Watt's steam engine. In this it is mentioned that the crucial idea did not come to Watt until two years after his first work on the Newcomen engine and six years after his first deliberate studies in the problems of heat.

Chapter III deals with pure and applied sciences and is followed by a particularly interesting and enlightening chapter on equipment of pre-Christian antiquity. Apt illustrations are given featuring the "swape" or well sweep in which the principle of the lever is involved; the crane using pulley blocks for greater lift; beam press with windlass; small screw press; the Archimedes water screw; cross-bow of Hero; Philo's force pump. Many other illustrations are included.

Development of water wheels, windmills and clocks then is treated and a chapter is devoted to the accomplishments of Leonardo da Vinci. Early days of the printing and textile industries are dealt with in succeeding chapters, after which developments in application of power and in machine tools are discussed. The book closes with a bibliography covering the primary materials used in preparation of the subjects presented.

* * *

Vibration from Unbalanced Forces

The Balancing of Engines, by W. E. Dalby; cloth, 321 pages, 6 x 9 inches; published by Longmans, Green & Co., New York, and supplied by MACHINE DESIGN for $8.40 plus 15 cents postage.

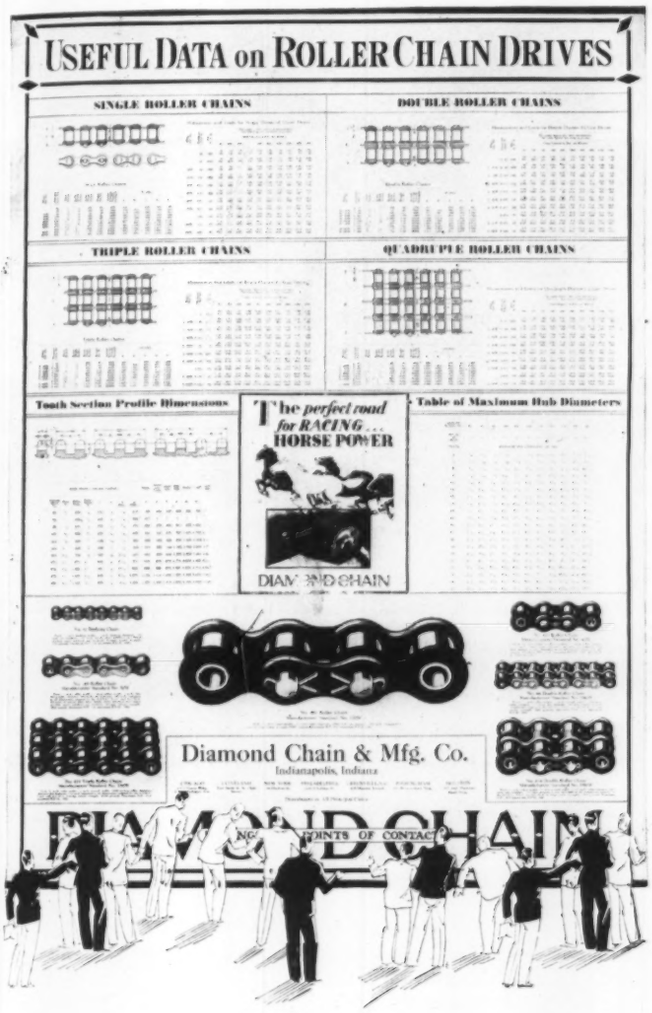
Ever recurring demands for increased speed bring into greater prominence this book on the correct balancing of engines. In it the author again expounds his method for the solving of balancing problems, which appeared in the first issue of the book published in 1902. This method has the advantage that it easily is checked. It now is accepted widely, having found its way into many text books.

As explained in Professor Dalby's preface the novelty of the method was the introduction of the idea of a reference plane which could be thought of as a drawing board, keyed to and revolving with the engine crankshaft. On this plane the force and couple polygons were drawn from elements found arithmetically by the aid of a schedule.

Early chapters deal with vector quantities and the balancing of revolving masses. Under the latter head important aspects of the subject are treated, including the balancing of any number of masses rigidly connected to an axis, by means of a single mass.

In the third chapter reciprocating masses are discussed and comprehensive examples again are included. Later sections of the book deal more specifically with problems of interest to railroad engineers and those concerned with secondary and higher orders of balancing. Particular attention is paid to the 4-crank engine because of the extensive use of this type.

All the Data you need on Roller Chain Drives—in convenient form


USEFUL DATA on ROLLER CHAIN DRIVES
SINGLE ROLLER CHAINS
DOUBLE ROLLER CHAINS
TRIPLE ROLLER CHAINS
QUADRUPLE ROLLER CHAINS
Tooth Section Profile Dimensions
The perfect road for RACING... HORSE POWER
Table of Maximum Hub Diameters
Diamond Chain & Mfg. Co.
Indianapolis, Indiana
ROLLING AT POINTS OF CONTACT

TRADE MARK

VALUABLE information for everyone concerned with power transmission is shown on this new wall chart—"USEFUL DATA ON ROLLER CHAIN DRIVES."

It enables you to select without trouble the proper roller chain and sprockets for any positive power drive you may have in mind. It gives the standard number, the corresponding Diamond Chain number of all chains from single to quadruple strand . . . as well as pitch, size, weight, speed, tensile strength, rated horse power and load in pounds. It also gives the sprocket hub diameters and tooth dimensions to correspond.

Various types of Diamond Chain are illustrated . . . including the *new No. 480 (2½" pitch)* chain . . . rated up to 408 horse power in the quadruple strand.

The size of this wall chart makes it easy to read and convenient to handle. It is provided with an eyelet for hanging up. A copy of the chart will be mailed upon request. Simply use the handy coupon.

Mail the Coupon for Wall Chart

DIAMOND CHAIN
ROLLING ~ AT POINTS OF CONTACT

DIAMOND CHAIN & MFG. CO.
435 Kentucky Ave., Indianapolis, Ind.

Offices and Distributors in All Principal Cities

DIAMOND CHAIN & MFG. CO.
435 Kentucky Ave., Indianapolis, Ind.

Gentlemen: Please send me your new wall chart: "USEFUL DATA ON ROLLER CHAIN DRIVES" without cost or obligation.

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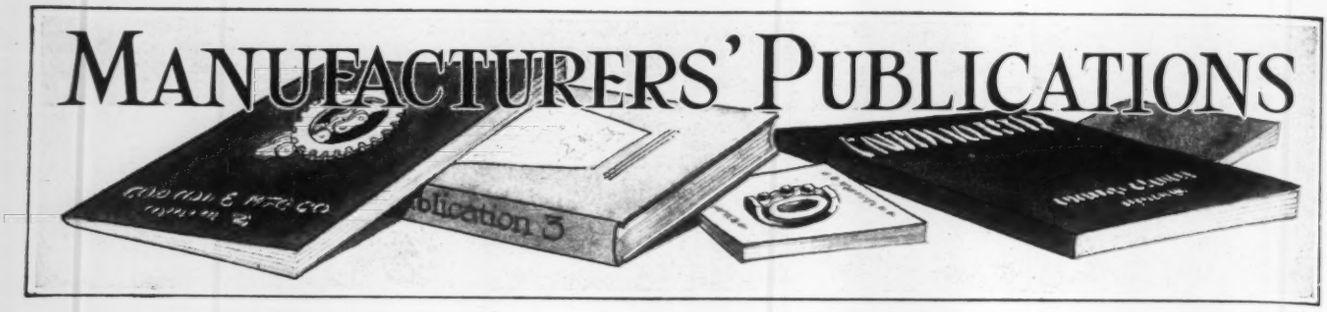
(A-805)

MANUFACTURERS' PUBLICATIONS



ELECTRICAL EQUIPMENT—General Electric Co., Schenectady, N. Y., in current bulletins, describes its hand-starting compensators and resistors. Illustrations and text cover these devices fully.

LOCK NUTS—Kraberhall Inc., Philadelphia, has prepared for distribution a movable cross-section of one of its pin-nuts, in which, by means of pins inserted tangentially between bolt and nut the latter is locked against loosening by vibration. Action of the pins is described in the text.

ROCK DRILL STEEL—A booklet on steels for rock drills has been issued by the Sullivan Machinery Co., Chicago. A chapter is devoted to pyrometers and pyrometer control and one on the magnetic indicator to indicate the critical point in heating steel for forging or tempering. Heat treating of drill steel is described.

BALL BEARINGS—Fafnir Bearing Co., New Britain, Conn., has issued a booklet on applications of its ball bearings in aircraft construction. It calls attention to the increasing use of these bearings in connection with airplane control mechanism as an added safety medium, and explains in detail the various ways they have been used. Charts and data sheets present facts as to use of the bearings for various parts.

CARBON CIRCUIT BREAKERS—A type of carbon circuit breakers is illustrated and described in a bulletin by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Illustrations show installations in a variety of uses. A brief history of the development of this type of circuit breakers is included in the foreword.

MOTOR CONTROL—A booklet devoted to practical pointers on the selection of motor control has been issued by Cutler-Hammer Inc., Milwaukee. It stresses the features to consider when choosing motor control, with reference to the motor's load, for alternating and direct current. It is written by an electrical engineer, in practical language. The text is supplemented by numerous illustrations.

VALVES—Edward Valve & Mfg. Co., East Chicago, Ind., has issued a leaflet containing reproduced advertisements of its product, designed to give engineers an idea of the care exercised in their manufacture.

ROLLER BEARINGS—American Roller Bearing Co., Pittsburgh, has combined in its current catalog a full presentation of its entire line of roller bearings designed particularly for heavy duty service in machinery and equipment. A useful feature is a series of drawings showing various methods of installation, relative to end-plate construction, doweling of inner races and control of thrust, as well as usual methods of installing bearings in many kinds of equipment.

NICKEL STEEL—International Nickel Co., New York, has prepared a reprint of a paper on the manufacture of nickel steel plate, from proceedings of the American Society of Mechanical Engineers. It deals with the manufacture, rolling and inspection of steels containing 2 to 3 per cent of nickel. It is illustrated.

STEEL CASTINGS—Electric Steel Founders' Research group has issued another number of the "Research Group News." It contains an article on details in small steel casting manufacture, and the A. S. T. M. specifications for ferrous castings, as well as other interesting current industrial literature.

ELECTRICAL APPLIANCES—General Electric Co., Schenectady, N. Y., as issued a number of bulletins on its products. These include: Constant-potential Arc-welding sets for several operators; pressure governor; controllers for wound-rotor C. C. induction motors; automatic welding head and control; magnetic controllers for constant-speed motors; electric gasoline gage for aircraft.

SPEED REDUCERS—Universal Gear Corp., Chicago, recently issued two booklets, one on its heliocentric speed reducer and the other on its revocentric variable speed reducer. Illustrations and diagrams show their design and construction and the text matter describes operation and application of these units. Tables helpful to the designer in studying this new equipment also are included.

VALVES—A booklet describing valves for air and special service recently was released by the Pratt & Cady Co., Bridgeport, Conn. Illustrations show different types which are described in the text.

VARIABLE SPEED TRANSMISSIONS—Descriptions and illustrations of Reeves variable speed transmissions make up a folder being circulated by the Reeves Pulley Co., Columbus, Ind. Installations of its units on many different types of machines are shown. These units are built in sixteen different sizes.

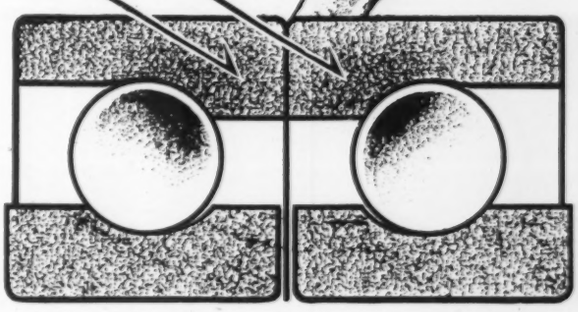
ALLOY METAL—Everdur, a copper-silicon-manganese is the subject of a pamphlet recently issued by the American Brass Co., Waterbury, Conn. Tables showing stress beyond elastic limit and physical tests of this alloy are given supplemented by descriptive text matter. Illustrations show products including bolts, piston rods, shafting, tube, etc., manufactured from it.

GENERATING SETS—Engberg division of the Troy Engine & Machine Co., St. Joseph, Mich., has issued a bulletin on its generators sets for stationary service. The engine and generator are shown in detail, with a drawing and table of dimensions.

IRON ORE—Shenango Furnace Co., Pittsburgh, is distributing a notebook and diary containing much information on Lake Superior iron ores and subjects allied to the lake trade in iron ore. Pig iron, coke and steel production and prices over a period of years are also covered.

GEARS—Grant Gear Works Inc., Boston, is distributing a catalog of its stock and special gears for industrial

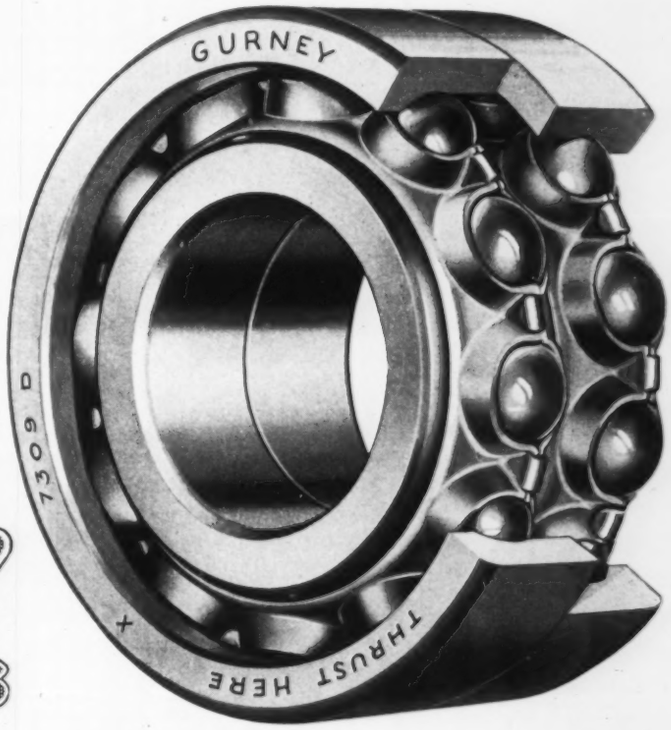
THESE HUSKY SHOULDERS CARRY ENORMOUS THRUST LOADS



Gurney Duplex Ball Bearings have husky shoulders — husky shoulders with accurately formed race contours presenting a maximum of surface for ball support.

In securing spindle rigidity the application of large initial thrust loads are necessary to defeat deflection. Clamp the Duplex, shoulder to shoulder and screw up the adjusting nut until the squeeze removes all possibilities of deflection.

Duplex rigidity is permanent rigidity—a warrant of controlled and productive accuracy. Build it into your product. Use the Gurney Duplex.



GURNEY BALL BEARING DIVISION
MARLIN-ROCKWELL CORP.
JAMESTOWN, N. Y.

GURNEY BALL BEARINGS

use in a wide variety of forms. It also covers speed reducers, flexible couplings and much information relating to these devices.

LUBRICATION—Texas Co., New York, devotes the current issue of its publication on lubrication to discussion of the relation of carbon residue to lubricating performance. An important section discusses the relation of operating conditions to carbon residue developments. To users of internal combustion engines, gas or diesel, the facts developed in this investigation are of much interest.

NICKEL ALLOY STEEL—International Nickel Co. Inc., New York, is distributing its revised buyers' guide of sources from which various descriptions of its nickel steel alloys may be obtained. It is a useful reference book for those using these materials.

RESISTANT METALS—A bulletin has been issued by the Duraloy Co., Pittsburgh, on its chromium and chromium-nickel steels for resistance to oxidation, corrosion and abrasion. It is well illustrated.

OVERLOAD SWITCH—A bulletin by Cutler-Hammer Inc., Milwaukee, features its new, free tripping thermal overload switch for fractional horsepower motors. It provides protection against overloads, blown fuses and other troubles.

BLUEPRINTING EQUIPMENT—C. F. Pease Co., 813 North Franklin street, Chicago, recently issued an attractive 24-page brochure describing its Peerless Model 30 blueprinting machine and continuous blueprinting equipment. Details of operation are clearly described and interestingly illustrated. Condensed specifications are given on the last two pages of the booklet.

FLEXIBLE COUPLINGS—Morse Chain Co., Ithaca, N. Y., has issued a booklet on its flexible couplings. The general subject is treated from various angles, touching on needs for this type of coupling, savings on bearings and machinery and lower maintenance cost. The principle of the coupling is explained and illustrations show typical installations. Data to guide in selection are given. The booklet also treats speed reducers and lower transmission service.

FLEXIBLE SHAFTING—S. S. White Dental Mfg. Co., New York, has issued a handbook on its flexible shafting. The process of manufacture is described and illustrated completely. The increasing use of flexible shafting in machine design is suggested as important as that of gears. A chapter is devoted to the various applications of this means of power transmission. The book is a compendium of information on the subject.

ELECTRICAL DEVICES—General Electric Co., Schenectady, N. Y., has issued bulletins as follows: Gas-engine-driven arc welder, direct current mill motors, method of determining cost of operating electric appliances and motors. Each is illustrated.

STEEL CASTINGS—Sivyer Steel Casting Co., Milwaukee, shows the application of specialization to production of steel castings, in a current bulletin, with special emphasis on great strength in thin sections.

PYROMETERS—Leeds & Northrup Co., 4901 Stenton avenue, Philadelphia, has issued its revised catalog No. 86 on optical pyrometers. It too is distributing its new revised catalog No. 87 on "Potentiometer Pyrometers" and a complete revision of its catalog No. 93 on "The Homo Method for Production Tempering." Notebook No. 4 is a new publication entitled "Notes on the Kelvin Bridge." These publications are illustrated and describe their respective subjects in a complete yet understandable way.

JANETTE *Motorized* SPEED REDUCERS

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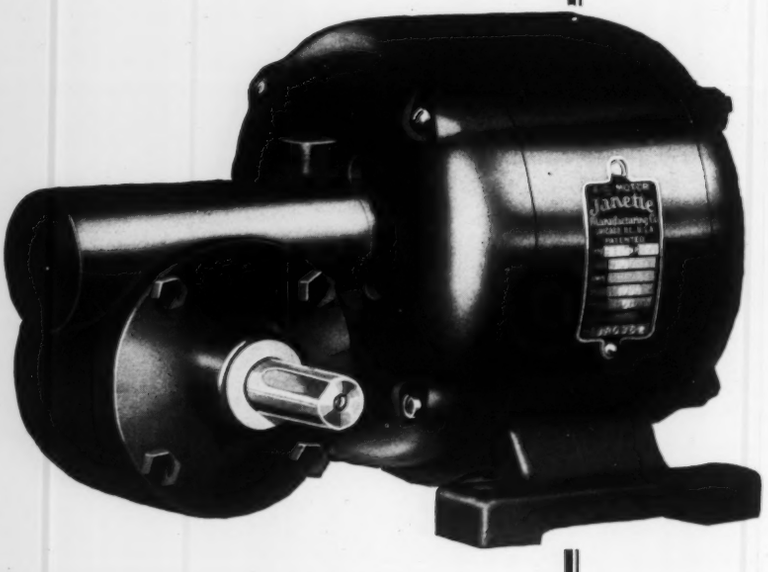

Compactness is the dominating feature of Janette Motorized Speed Reducers—compactness *plus* sturdiness. These units embody motor, coupling and speed reducer in a single machine of small size and pleasing design.

Quickly Mounted

Janette Motorized Speed Reducers eliminate several assembly operations when mounted on a motor-driven appliance. No couplings. No separate gear housings. Just like mounting on ordinary motors.

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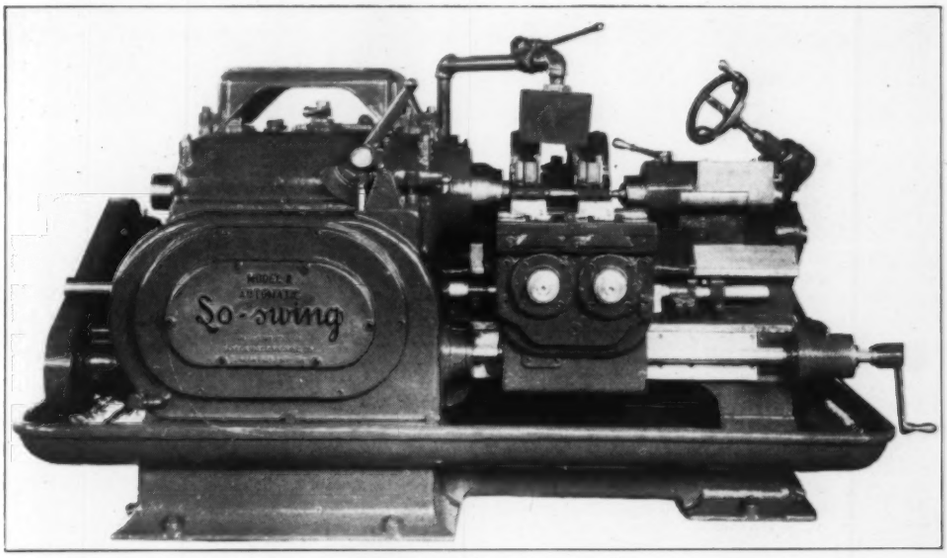

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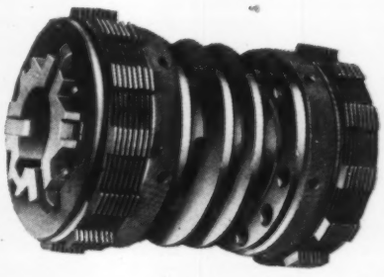

PARTS STATIONS

Boston, Mass.—Rapp-Huckins Co., Inc., 138 Beverly St.
Buffalo, N. Y.—Edward W. Rode, 45 A. St.
Cleveland—Industrial Engine Parts, Inc., 1053 E. 61st St.
Chicago—Motive Parts Co. of America, Inc., 2419 Indiana Ave.
Des Moines—Motive Parts Co. of America, Inc., 1204 W. Grand Ave.
Detroit—Whitney Brothers, 6464 Epworth Blvd.
Fort Worth, Tex.—Fort Worth Wheel & Rim Co., 312 Throckmorton St.
Houston, Tex.—Portable Rig Co., Inc.
Knoxville, Tenn.—Automotive Equipment & Supply Co.
Los Angeles—Coast Machinery Corporation, 464 E. Third St.
New York City—John Reiner & Company, Inc., 290 Hudson St.
Philadelphia, Pa.—Maerky Machine Works, 632 Race St.
Pittsburgh, Pa.—A. H. Krigger & Co. Smithfield & Carson Sts. Court 2496.
Raleigh N. C.—Motor & Equipment Co., 215 E. Davie St.
San Francisco—F. Somers Peterson Co., 57 California St.
Seattle, Wash.—Pacific Hoist & Derrick Company, 818 First Ave. South.
Tulsa, Okla.—Buda Engine Service Co. of Tulsa, Inc.

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These clutches are exceedingly compact. The entire operating mechanism is contained in the hub.

They have extraordinary capacity for size. They start smoothly and carry effectively every load the machine is designed to handle.

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